February 2012

Readmissions Due to Hospital-Acquired Conditions (HACs)

Final Report

Prepared for

Linda A. Radey, PhD
Centers for Medicare & Medicaid Services
Office of Research, Development, and Information
Mail Stop C3-19-26
7500 Security Boulevard
Baltimore, MD 21244-1850

Prepared by

Amy Kandilov, PhD
Nancy McCall, ScD
Kathleen Dalton, PhD
Richard D. Miller, Jr., PhD
RTI International
3040 Cornwallis Road
Research Triangle Park, NC 27709

RTI Project Number 0209853.230.001.088

Readmissions Due to Hospital-Acquired Conditions (HACs)
Final Report

by Amy Kandilov, PhD
Nancy T. McCall, ScD, Project Director
Kathleen Dalton, PhD
Richard D. Miller, Jr., PhD

Federal Project Officer: Linda A. Radey, PhD

RTI International

CMS Contract No. HHSM-500-2005-00029I

February 2012

This project was funded by the Centers for Medicare & Medicaid Services under Contract No. HHSM-500-2005-00029I. The statements contained in this report are solely those of the authors and do not necessarily reflect the views or policies of the Centers for Medicare & Medicaid Services. RTI assumes responsibility for the accuracy and completeness of the information contained in this report.

RTI International is a trade name of Research Triangle Institute.

ACKNOWLEDGMENTS

We would like to acknowledge assistance we received in conducting analyses related to hospital readmissions and preparing this report for submission. First, we would like to thank Sarah Siegel, Merry Rabb, and Matt Urato who provided valuable assistance in the construction of the episode-of-care linked file that made this analysis possible, and in programming assistance through the analysis phase. We would also like to thank Terry Eng and Julie Lynch for expert assistance in the identification of clinical risk factors associated with the risk of readmission and researching and describing the clinical presentation of mediastinitis. Lastly, we would like to thank Norma DiVito for assistance with preparation of this report.

CONTENTS

List of Figures

List of Tables

SECTION 1
INTRODUCTION AND OVERVIEW OF RESEARCH APPROACH

1.1 Introduction and Findings from Previous Research

This report analyzes the effects of the hospital-acquired conditions-present on admission (HAC-POA) program on utilization, with a specific focus on readmissions. The HAC-POA program was designed to improve the quality of inpatient care to Medicare beneficiaries by providing a negative financial incentive, in which inpatient prospective payment system (IPPS) cases can no longer be assigned to higher-paying MS-DRGs on the basis of reasonably preventable complication or comorbidity (CC) or major complication or comorbidity (MCC) conditions that are acquired during the hospital stay. The reimbursement effects are limited to the initial or index admission only. Thus, even though the hospital may not receive a higher rate of payment for index admissions in which a HAC occurred under the HAC-POA program, hospitals could receive additional payments from the Medicare program for care provided during readmissions related to the hospital-acquired condition.

Previous research has shown to varying degrees that the likelihood of readmission is greater for patients who experience adverse events than for similar patients who have no such adverse events (Ashton et al., 1997; Herwaldt et al., 2006; Encinosa and Hellinger, 2008; Friedman et al., 2009; Friedman and Basu, 2004). Ashton and colleagues (1997) conducted a meta-analysis of the relationship between early readmission rates (31 days) and inpatient processes of care and concluded that substandard care was correlated with higher readmission rates; patients who were readmitted for unplanned reasons were 55% more likely to have had poor quality of care.

Encinosa and Hellinger (2008) studied the occurrence of seven categories of Agency for Healthcare Research and Quality (AHRQ) patient safety indicators (PSIs) among 161,004 privately insured patients undergoing surgery; these seven groups of PSIs span the 10 HAC categories in this study. Excessive 90-day readmission rates were found for four of the seven PSI groups: infections (7.7%), pulmonary and vascular problems (3.4%), acute respiratory failure (4.3%), and metabolic problems (6.3%).

Infections after surgical procedures are an important reason for early readmissions and have been the focus of a number of recent studies. Herwaldt and colleagues (2006) studied postoperative nosocomial infections associated with general, cardiothoracic, and neurosurgical procedures in a large tertiary care medical center and associated VA hospital. They found that the risk adjusted odds ratio of being readmitted within 30 days of surgery ranged across the three surgical services from 2.15 to 5.62 for patients with a SSI compared with patients with no SSI.

Friedman and colleagues (2009) used an all payer data set of hospitalizations for surgical procedures from seven states and found that the relative risk of readmission was higher for patients experiencing at least one of nine PSIs. The unadjusted rate of 3-month readmission was 25% among patients with a positive PSI compared with 17% among those without a positive PSI. Risk adjustment reduced the 3-month readmission rate differences yet the rates remained statistically higher for patients with each of the nine PSIs.

The most recent literature points to a similar relationship between hospital-acquired conditions and readmissions. Morris et al. (2011) considered unplanned 30-day same-hospital readmissions among 1,808 surgical patients in an urban, tertiary hospital in FY 2009 and found that deep vein thrombosis significantly increased the probability of a readmission, with an odds ratio of 4.7. The reasons for readmission among these patients, however, did not seem to be related to the deep vein thrombosis.

1.2 Overview of Phase II Research Questions and Analytic Approach

For all cases identified as a HAC and discharged alive, we address the following research questions:

- What are the frequencies and rates of readmission by type of HAC? How do the readmission rates increase as the readmission window increases from 7 days up to 60 days?
- Did the readmission rates change between 2009 and 2010?
- What are the most common reasons for readmission? Have reasons for readmission changed between 2009 and 2010?

To address the incremental effect of a HAC on readmissions, however, it is necessary to develop a valid comparison group. As described below, we selected three HACs where the data from FY 2009 claims analyses showed sufficient volume to support more detailed analyses. These are: falls and trauma; vascular catheter-associated infections; and DVT/PE following certain orthopedic procedures. We developed a comparison study sample for each of these HACs that included a random sample of discharges matched to the HAC cases by key clinical and demographic characteristics. For each of these three study samples, we address the following additional study questions:

- Are there differences in readmission rates between cases that have HACs and similar cases that do not report HACs?
- If so, are they similar in FY 2009 and FY 2010?
- Do these differences persist if we stratify for key patient characteristics that were not included as matching criteria?
- Do these differences persist if we stratify by key hospital characteristics?
- Do reasons for readmission differ between cases that have HACs and similar cases that do not report HACs?

Due to the strong possibility of under-reporting of HACs in the first years of the HAC-POA program, we also created a separate study sample of discharges that were coded with the HAC-associated diagnoses, but where the diagnosis was coded as present-on-admission (i.e.

POA, rather than not POA). For this subset, we looked back in time in the MedPAR files to address the following:

- How often is there a *preceding* admission within 60 days of the "POA admission"?

- For those cases with a preceding admission, in what proportion of the preceding claims do we find the HAC on the preceding claim?

Finally, we created a separate study sample to conduct further investigations on the HAC of mediastinitis following coronary artery bypass graft (CABG) surgery. The number of mediastinitis cases that were hospital-acquired HACs is very small so we undertook this study to examine the possible degree of under-reporting of mediastinitis during the hospital period or clinical presentation of mediastinitis after discharge. The primary motivation for this study is to examine the degree to which readmission estimation bias may exist due to identification errors in the dependent variable because of either under-reporting of the HAC by the hospital or a delay in clinical presentation until after discharge.

The mediastinitis study sample includes all discharges with a CABG procedure in either FY2009 or FY2010. We linked the MedPAR records for these discharges with all physician claims billed during the admission and all physician and hospital outpatient department claims for a 60-day follow-up period and explored the reporting of mediastinitis by physicians during the hospitalization and follow-up periods. For this sample, we answer the following research questions:

- What proportion of CABG cases is identified with mediastinitis during the hospitalization period from physician claims and what is the degree of concordance with the MedPAR claim diagnosis of mediastinitis?

- For CABG cases with a physician-reported diagnosis of mediastinitis, what is the proximity of the diagnosis to the day of surgery?

- What proportion of CABG cases with and without hospital-reported mediastinitis have an infection disease consultation and what are the 10 top reasons for the consult?

- What percentage of beneficiaries have an ambulatory encounter within 7, 15, and 30 days post-discharge with their primary surgeon or to any provider and what are the top 10 reasons for the ambulatory visit?

It is important to note that we had proposed a more robust analysis in our previously submitted and accepted Strategy Memo. However, preliminary review of physician billing during and post-discharge for mediastinitis or possibly related clinical conditions was extremely minimal making many of the proposed analyses impractical.

SECTION 2
TECHNICAL APPROACH

2.1 Study Samples and Data

For the primary analysis of readmissions among patients with hospital-acquired conditions (HACs), we created our study sample by linking Medicare claims data to "index" HAC IPPS hospital claims. These "index" claims were defined as claims with the HAC-associated diagnoses coded as not present on admission (POA indicator = "N" or "U"). The index HAC claims were taken from MedPAR files for FY 2009 and the first ten months of FY 2010, to allow for a 60-day look-forward period as described in the next paragraph. From these index HAC claims, we used a cross-referenced beneficiary identifier (HIC number) to look back 180 days prior to the index admission date in order to identify any Medicare claims (inpatient, outpatient, home health, and physician claims) for that patient within that period. The claims data for the look-backs came from FY 2008, FY 2009, and FY 2010, as needed. These look-back claims were used to calculate a concurrent Hierarchical Condition Category (HCC) score for these patients and to generate indicators of pre-existing medical conditions. We then used the HIC number to look forward 60 days from the index discharge date for additional hospital admissions. If a patient was discharged from their index HAC hospitalization and admitted to another IPPS hospital within a day (with a discharge designation of an acute care transfer), then the 60-day follow up period began with the discharge date from that second transfer hospitalization.

The study sample was limited to beneficiaries who were residents of the U.S., who were enrolled in Medicare Parts A & B, who did not have Medicare as a secondary payer, and who were *not* enrolled in managed care during their HAC index claim, during the 180 days prior to the index admission, and during the 60-day period following the index discharge. The sample was also limited to patients who were discharged alive from their index hospitalization. These exclusions allowed us to focus on Medicare patients with HACs who could possibly have had a readmission and whose readmission claims we would likely find using MedPAR claims data. For example, if a Medicare beneficiary with an index HAC admission switched to Medicare managed care during the 60-day follow-up period, any hospital readmissions they might have had would not be present in the MedPAR claims data. Including these beneficiaries in the sample could lead to an under-estimation of the readmission rates.

For the separate study of the present on admission (POA) claims (see **Section 5.1** and **Table 8**), the index claims were defined as those with the HAC-associated diagnoses coded as present on admission (POA indicator = "Y" or "W"). From these index POA claims, we used the cross-referenced HIC number to look back 60 days prior to the index admission for a previous IPPS hospital discharge. The study sample was limited to beneficiaries who were residents of the U.S., who were enrolled in Medicare Parts A & B, who did not have Medicare as a secondary payer, and who were not enrolled in managed care during both their POA index claim and the 60-day period before the index hospitalization. Note that we did *not* limit this study sample to those discharged from the index hospitalization alive, since the outcome of interest was the hospitalizations occurring *before* the index hospitalization.

In our examination of mediastinitis following CABG surgery (see **Section 5.2**), we also linked physician claims that occurred during the index hospitalization for Medicare beneficiaries who had a CABG procedure. We linked the MedPAR records for these discharges with all physician claims billed during the admission and all physician and hospital outpatient department claims for a 60-day follow-up period This sample was also limited to live discharges who were residents of the U.S., who were enrolled in Medicare Parts A and B, who did not have Medicare as a secondary payers, and who were not enrolled in managed care during the relevant study period.

2.2 Defining Readmissions

For the statistics presented in this report, we use a measure of hospital all-cause readmissions and include all admissions to acute care hospitals that occur within 60 days of the index claim discharge date, regardless of the clinical reason for the admission. In addition to IPPS hospitals, an admission to a critical access hospital (CAH) or to another non-IPPS hospital that is paid under Medicare Part A (such as a Cancer hospital or a Children's hospital) following an index IPPS hospital discharge is considered a readmission. Discharges from the index hospitalization to another acute care IPPS hospital, where the index discharge date is within one day of the next admission date and the discharge destination is a transfer, are treated as transfer cases and so are not included as readmissions. The 60-day look-forward period begins with the discharge date of the transfer hospitalization, if there is one.

In calculating the readmission rate for each HAC, we divide the number of patients who have at least one readmission by the total number of patients who were discharged alive with that HAC and multiply by 100. Patients with multiple readmissions within the specified window are counted the same as patients with a single readmission, though it is interesting to note that when we examine all ten HACs and look at the 60-day readmission window, about 30 percent of the patients with a readmission have multiple readmissions.

We present our initial readmission statistics using four different time windows in which the readmissions can occur: 7-days, 15-days, 30-days, and 60-days. In our preliminary analysis, we observed considerable stability in the primary reasons for readmission across all four window periods across all 10 HACs; and we believe the data suggest that all four windows provide roughly the same degree of clinical relevance.

2.3 Selection of Three Study HACs

Based on our initial descriptive statistics produced for the Strategic Memo: Strategy to Estimate Readmissions Due to Hospital-Acquired Conditions (HACs), we selected three HACs from the current set of HACs for further analysis in this report. The primary criterion for our selection was that the chosen HACs have a sufficient volume to estimate statistically reliable descriptive statistics, allowing us to examine variation in readmission rates across beneficiary characteristics. Using this criterion, we selected the following three HACs for the Phase II report:

- ***Falls and trauma***, with 7,954 HAC-associated live discharges in FY 2009 and the first 10 months of FY 2010.

- ***Deep vein thrombosis and pulmonary embolism*** following certain orthopedic procedures, with 4,195 HAC-associated live discharges in FY 2009 and the first 10 months of FY 2010.
- ***Vascular catheter-associated infection*** with 5,167 HAC-associated live discharges in FY 2009 and the first 10 months of FY 2010.

One area of considerable concern is under-estimation of the number of surgical site infections (SSIs) identified during the index hospitalization in which the surgery occurs. Although we have a high degree of confidence that Medicare claims coded with a SSI are true positive SSIs given the potential negative payment impact, we have less confidence that Medicare claims coded without the SSI HACs are true negative SSIs. In addition to our three study HACs, we explored the potential degree of under-reporting by hospitals or post-discharge clinical manifestation of ***mediastinitis related to CABG*** as an additional HAC for this study; this is an important procedure to the Medicare FFS population and a complication that can have significant morbidity effects.

2.4 Comparison Group Matching Criteria

Section 3.3 of the Strategic Memo: Strategy to Estimate Readmissions Due to Hospital-Acquired Conditions (HACs) describes a method for developing a valid comparison group that involves selecting episodes based on a small set of clinical or demographic characteristics held in common with the specific HAC cases, and then using a larger set of covariates in the outcome regressions (which will be part of the analysis in the Phase III report). As described in the literature review, matching is a common technique found among empirical studies on this topic. For the descriptive analysis in this report, we took a multivariable matching approach. Multivariable matching uses a limited number of specific characteristics and identifies controls that match on *all* of these.

To construct appropriate comparison groups for the three selected study HACs, we matched each index claim identified with a HAC to 10 IPPS claims without a HAC but with the same MS-DRG and demographic characteristics (sex, race, and age) as the HAC claim. In the cases where a 10:1 match was not obtainable, we reweighted the matches that were made to simulate a 10:1 match. Any claims with the HAC-associated diagnosis codes identified as present on admission (POA indicator equal to “Y” or “W”) were excluded from the comparison group, since conditions coded as present on admission could potentially be true HACs that were miscoded. Including true HACs in the comparison group could introduce bias in our results. Thus, the comparison group for each of the three HACs contained no index claims with the specified HAC-associated diagnoses.

No additional restrictions were placed on the comparison group for the falls and trauma HACs. For the DVT/PE following certain orthopedic procedures, the set of claims from which the comparison group was drawn was further limited to those claims containing the orthopedic procedure associated with this HAC. To better target the population who would be at risk for a vascular catheter associated infection, we limited this comparison group to index claims that had one of two vascular catheter procedure codes (38.93 or 38.95). Note that among patients with the vascular catheter associated infection HAC, 38 percent did not have a vascular catheter procedure code on their claims. The vascular catheter codes may have been coded after the fifth surgical procedure code, and thus not picked up by the MedPAR data, or may have been left off of the claim completely. Readmission rates were similar between the HAC claims that included the vascular catheter procedure codes and those that did not include the codes. We anticipate that the results from our Accuracy of Coding task may allow us to identify more accurate claims proxies for the presence of a vascular catheter.

From these index comparison claims, we linked additional claims data both before and after the index comparison claim, as described in **Section 2.1**, in order to calculate readmission rates, HCC scores, and pre-existing conditions. The same sample exclusions – residents of the U.S., enrolled in Medicare Parts A & B, Medicare not the secondary payer, and not enrolled in managed care – were applied to the identified comparison groups to ensure analogous samples.

For the analysis of mediastinitis following CABG, the index claims for our comparison group consisted of all IPPS hospital claims with the surgical procedure codes for CABG. As described in **Section 2.1**, we linked these claims with physician claims that occurred during the index hospitalization, as well as physician and hospital outpatient department claims occurring in the 60 days following the index discharge.

2.5 Constructing "Unplanned" Readmission Rates

To test the robustness of the results to the definition of readmission used in this report, a measure of "unplanned" all-cause readmissions was examined. The measure was first proposed in a report to CMS by the Yale New Haven Health Services Corporation/Center for Outcomes Research and Evaluation (referred to as Yale for the remainder of this report). The Yale definition essentially drops certain readmissions that appear to have been planned. The justification for this is that planned readmissions would not necessarily be indicative of poor medical care during the original or index admission. For instance, a patient may need to be admitted for maintenance chemotherapy within 30 days of a previous discharge, but this admission would not likely indicate anything regarding the quality of care provided during the previous admission.

To discriminate between planned and unplanned admissions, the Yale researchers compiled a list of inpatient procedures that may be considered "potentially planned." Using the Agency for Healthcare Research and Quality (AHRQ) Clinical Classification Software (CCS), ICD-9 codes were collapsed into 231 mutually exclusive procedure categories. Next, a list of 33 CCS procedure code categories (plus five additional ICD-9 procedure codes) were identified as indicative of an admission that may have been planned. Some of the more common procedures included on the list were percutaneous transluminal coronary angioplasty (PTCA), rehabilitation, cholecystectomy and common duct exploration, and amputation of a lower extremity. The full procedure list can be found in **Appendix Table A-1.**

To determine which of these potentially planned readmissions were actually planned, information regarding the principal diagnosis was used. If the potentially planned readmission was for an acute condition or for a complication of care, then it would be defined as unplanned, otherwise it would be defined as planned. To understand the logic, consider the case of a patient being admitted for PTCA. Such a readmission with a principal diagnosis of coronary atherosclerosis would be considered planned, since coronary atherosclerosis is a chronic condition. A readmission with a principal diagnosis of acute myocardial infarction would be considered unplanned, since it would be reasonable to assume that the PTCA was performed in response to the acute event and thus not planned ahead of time.

To identify those readmissions that were for acute conditions or for complications of care, the Yale researchers again used the AHRQ CCS to collapse ICD-9 codes into 285 mutually exclusive condition categories. Next, they reviewed the ten most frequent condition categories associated with each of the potentially-planned procedures identified earlier. Finally, they created a list of conditions that would be considered to be acute or indicative of complications with care. The most common conditions included on the list were complications with devices, implants, or grafts; cardiac dysrhythmias, fractures, acute myocardial infarction, and complications of surgical procedures and medical care. The full list of conditions can be found in **Appendix Table A-2**.

Planned readmissions were thus identified using the following algorithm. A readmission would be considered planned if:

1. The readmission was for maintenance chemotherapy or rehabilitation, OR
2. The readmission included a procedure identified as being potentially planned (see **Appendix Table A-1**), AND did not have a principal diagnosis identified as either acute or indicative of a complication of care (see **Appendix Table A-2**).

We applied this algorithm to the all-cause readmissions we had identified and dropped all planned readmissions from further analysis, leaving just those readmissions that had been unplanned. In addition to replicating Yale's methodology for defining unplanned readmissions, we applied several additional exclusions to index admissions file for both the HAC and comparison groups. These exclusions were also used in the Yale study and we applied them so as to replicate Yale's methodology as closely as possible. The exclusions included:

- any index admissions for patients less than 65 years of age
- any index admissions where the patient was discharged against medical advice
- any index admissions where the patient received medical treatment for cancer (see **Appendix Table A-3** for the list of condition CCSs used to identify such admissions)
- any index admissions where the patient was admitted for psychiatric treatment (see **Appendix Table A-4** for the list of condition CCSs used to identify such admissions)
- any index admissions where the patient received rehabilitation.

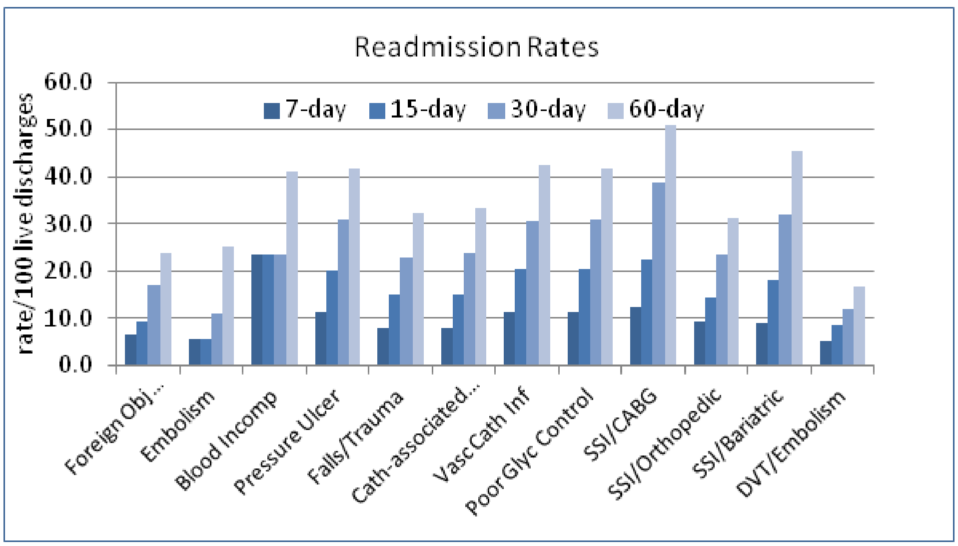
One noted deviation from the methodology used by the Yale researchers is the lack of application of their risk adjustment approach. We did not implement their risk adjustment method for two reasons. First, we are not comparing readmission rates across hospitals that may have very different cases mixes. Rather, we are comparing readmission rates between beneficiaries with and without selected HACs. Thus, we selected our comparison group using sociodemographic characteristics as well as health status characteristics determined before hospitalization (such as the concurrent HCC score) to create 'risk-adjusted' comparison cohorts. Further risk adjustment seemed unnecessary.

SECTION 3
READMISSION DESCRIPTIVE STATISTICS: ALL HACS

3.1 Readmission Frequencies and Rates in the First Two Years of the HAC-POA Program

For the group of patients who developed one or more of the 10 HACs, the readmission rate averaged 9 per 100 live discharges within 7 days of discharge, rising to 16/100 within 15 days, 24/100 within 30 days and 33/100 within 60 days. **Figure 1** displays all-cause readmission rates for each of the HACs, computed over each of the four observation periods. Frequencies and other statistics underlying this figure are provided in **Table 1**. The data reflect HACs identified in the Medicare claims files over the first two years of the HAC-POA program, but recall that in order to accommodate a 60-day period in which to observe readmission, the study population includes IPPS discharges from all 12 months of FY 2009 but only the first ten months of FY 2010.

Figure 1
HAC readmission rates by days in the readmission window



NOTES: 1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010

SOURCE: Readmissions analysis Tables Nov 2011.do

With the exception of the blood incompatibility and air embolism HACs, which are very small groups to start with (and have only 9 and 7 readmissions in total, respectively), the rates increase as expected with the lengthening of the observation window. The longer the window, the greater the chance that a readmission is due to other unrelated health problems and less likely that the readmission is related to the HAC.

The first column in **Table 1** shows the number of live discharges for each HAC, defined as the number with a HAC-associated secondary diagnosis code or diagnosis code-procedure pair that was not present on admission (i.e., POA indicator of “N” or “U”). We then show the number of all-cause readmissions and rates per 100 live discharges for each of four fixed readmission windows.

The number of live discharges with any one of the HACs ranges from a low of 17 for blood incompatibility to a high of 7,954 for falls and trauma. Given the relative low frequencies of index admissions for many of the HACs in this readmission analysis, it is not surprising to also see low absolute numbers of readmissions. Rates are initially lowest for the DVT/PE HAC (5 per 100 at 7 days, rising to 17/100 at 60 days) and highest for blood incompatibility (24/100 at 7 days, rising to 41/100 at 60 days). By 60 days, the highest readmission rate is 51 per 100 live discharges in the group with mediastinitis following CABG surgery.

In **Table 2,** we display the rates of readmission for the HAC claims by year, to ascertain if there was any change between the first and second year of the HAC-POA program implementation. **Table 2a** shows results for a 30-day window and **Table 2b** examines a 60-day window. The frequency of the HACs is lower for many of the conditions in FY 2010 compared to FY 2009, but this is because we used only 10 months of data to identify our index cases.

There is variation in the degree of year-to-year changes in readmission rates across the 10 HACs with some rate changes appearing to be quite substantial, but several of these are based on low absolute numbers and are therefore expected to show instability. At 60 days, the rates in 2010 were lower than the rates in 2009 for 4 HACs and higher for 8 HACs (counting each of the 3 SSIs separately). Using the 30-day window, the largest changes from FY 2009 to FY 2010 are seen among three surgical site infection HACs (increasing for mediastinitis and SSIs following orthopedic procedures, but declining for SSIs following bariatric surgery), but these are also among the lowest volume HACs. HACs with a higher number of cases show less variability between the two years. For the 5 HACs reported in roughly 1,000 to 4,500 cases, the rates of change range from -0.6/100 to 2.3/100. This translates into percent changes ranging from -4% to 9%. We generally see a similar pattern and of the same order of magnitude of change when examining the 60-day window. One exception is DVT/PE following certain orthopedic procedures; 30-day readmission rates showed a decline of 5% between FY 2009 and FY 2010, but the 60-day readmission rates showed an increase of 3% between the two years. Year-to-year volatility in rates is to be expected in these statistics, and we will need to see several years of data before we can assess any trends.

3.2 Most Common Reasons for Readmission

The single most common reason for readmission across all of the cases identified with HACs in the two-year study period is septicemia. Our initial review of the principal diagnoses for all-cause readmissions indicated that the only planned admission that is common in our study population is for chemotherapy, which accounted for 4% of readmissions in the vascular catheter-associated infections HAC. In this section and in **Sections 4.1** and **4.2**, we report the readmission rates for all-cause readmissions; in **Section 4.3**, we report the readmission rates using only unplanned readmission, which exclude planned readmissions such as chemotherapy.

Table 1
All-cause readmissions for discharges with CMS hospital-acquired conditions
FY 2009 and 2010

Hospital-acquired condition	Number of live discharges not POA	7-day window		15-day window		30-day window		60-day window	
		Number of patients with at least 1 readmit	Rate per 100 live discharges	Number of patients with at least 1 readmit	Rate per 100 live discharges	Number of patients with at least 1 readmit	Rate per 100 live discharges	Number of patients with at least 1 readmit	Rate per 100 live discharges
Foreign object retained after surgery	344	22	6.4	32	9.3	59	17.2	82	23.8
Air embolism	36	2	5.6	2	5.6	4	11.1	9	25.0
Blood incompatibility	17	4	23.5	4	23.5	4	23.5	7	41.2
Pressure ulcer stages III and IV	1,867	214	11.5	374	20.0	577	30.9	777	41.6
Falls and trauma	7,954	641	8.1	1,184	14.9	1,810	22.8	2,575	32.4
Catheter-associated urinary tract infection	5,013	405	8.1	753	15.0	1,199	23.9	1,672	33.4
Vascular catheter-associated infection	5,167	590	11.4	1,049	20.3	1,585	30.7	2,187	42.3
Manifestations of poor glycemic control	626	71	11.3	127	20.3	193	30.8	261	41.7
Surgical site infection, mediastinitis, following CABG	49	6	12.2	11	22.4	19	38.8	25	51.0
Surgical site infection following certain orthopedic procedures	299	28	9.4	43	14.4	70	23.4	93	31.1
Surgical site infection following bariatric surgery for obesity	22	2	9.1	4	18.2	7	31.8	10	45.5
Deep vein thrombosis and pulmonary embolism following certain orthopedic procedures	4,195	220	5.2	354	8.4	508	12.1	697	16.6
Total	25,589	2,205	8.6	3,937	15.4	6,035	23.6	8,395	32.8

NOTES: 1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010

SOURCE: Readmissions analysis Tables Nov 2011.do

Table 2
Year-to-year change in all-cause readmissions for discharges with CMS hospital-acquired conditions

2A: 30-day readmission window

	Number of live discharges not POA		Number of patients with at least 1 readmission		Rate per 100 live discharges		Change in rate between FY 2009 and FY 2010	
Hospital-acquired condition	FY 2009	FY 2010*	FY 2009	FY 2010*	FY 2009	FY 2010*	Difference	Percent
Foreign object retained after surgery	184	160	32	27	17.4	16.9	–0.5	–3%
Air embolism	19	17	2	2	10.5	11.8	1.2	12%
Blood incompatibility	9	8	2	2	22.2	25.0	2.8	13%
Pressure ulcer stages III and IV	977	890	291	286	29.8	32.1	2.3	8%
Falls and trauma	4,449	3,505	988	822	22.2	23.5	1.2	6%
Catheter-associated urinary tract infection	2,425	2,588	553	646	22.8	25.0	2.2	9%
Vascular catheter-associated infection	2,434	2,733	761	824	31.3	30.2	–1.1	–4%
Manifestations of poor glycemic control	319	307	92	101	28.8	32.9	4.1	14%
Surgical site infection, mediastinitis, following CABG	31	18	10	9	32.3	50.0	17.7	55%
Surgical site infection following certain orthopedic procedures	153	146	32	38	20.9	26.0	5.1	24%
Surgical site infection following bariatric surgery for obesity	14	8	5	2	35.7	25.0	–10.7	–30%
Deep vein thrombosis and pulmonary embolism following certain orthopedic procedures	2,321	1,874	287	221	12.4	11.8	–0.6	–5%

NOTES: 1. RTI analysis of live discharges for FY2009 and months 1 through 10 of FY2010 MedPAR data and subsequent readmission for up to a 30-day window.

SOURCE: Readmissions analysis Tables Nov 2011.do.

Table 2 (continued)
Year-to-year change in all-cause readmissions for discharges with CMS hospital-acquired conditions

2B: 60-day readmission window

	Number of live discharges not POA		Number of patients with at least 1 readmission		Rate per 100 live discharges		Change in rate between FY 2009 and FY 2010	
Hospital-acquired condition	FY 2009	FY 2010	FY 2009	FY 2010	FY 2009	FY 2010	Difference	Percent
Foreign object retained after surgery	184	160	47	35	25.5	21.9	–3.7	–14%
Air embolism	19	17	4	5	21.1	29.4	8.4	40%
Blood incompatibility	9	8	4	3	44.4	37.5	–6.9	–16%
Pressure ulcer stages III and IV	977	890	395	382	40.4	42.9	2.5	6%
Falls and trauma	4,449	3,505	1,378	1,197	31.0	34.2	3.2	10%
Catheter-associated urinary tract infection	2,425	2,588	790	882	32.6	34.1	1.5	5%
Vascular catheter-associated infection	2,434	2,733	1,051	1,136	43.2	41.6	–1.6	–4%
Manifestations of poor glycemic control	319	307	128	133	40.1	43.3	3.2	8%
Surgical site infection, mediastinitis, following CABG	31	18	14	11	45.2	61.1	15.9	35%
Surgical site infection following certain orthopedic procedures	153	146	42	51	27.5	34.9	7.5	27%
Surgical site infection following bariatric surgery for obesity	14	8	7	3	50.0	37.5	–12.5	–25%
Deep vein thrombosis and pulmonary embolism following certain orthopedic procedures	2,321	1,874	380	317	16.4	16.9	0.5	3%

NOTES: 1. RTI analysis of live discharges for FY2009 and months 1 through 10 of FY2010 MedPAR data and subsequent readmission for up to a 60-day window.

Computer run: Readmissions analysis Tables Nov 2011.do.

We examined the most common reasons for readmission for both a 30- and 60-day window using the principal diagnosis. **Table 3a** lists the five most common principal diagnoses for readmissions identified in the 30-day window subdivided by fiscal year, in order to address the question of whether or not the primary reasons for readmissions changed during the first 2 years of the HAC-POA program. **Table 3b** presents a similar list of the five most common principal diagnoses for readmissions, but using a 60-day window for the readmissions. Septicemia or other postoperative infections or post-procedure complications are dominant reasons for readmission across most of the HAC discharges, and we found this to be true whether the window was 30 days or 60 days from the index discharge date. Scanning across each HAC discharge, one generally observes the same four or five principal diagnoses appearing throughout the lists, though appearing in different orders of based on the frequency among readmissions. Generally speaking, one observes considerable stability for primary reasons for readmission across the two readmission windows considered, and few differences between FY 2009 and FY 2010.

Many of the top reasons for readmissions appear to be related to the HACs themselves. For example, the diagnosis code for pressure ulcers shows up in the top five reasons for readmissions among patients with a pressure ulcer HAC, and urinary tract infections are a common cause for readmissions among patients with a hospital-acquired catheter-associated UTI. Diabetic patients with hospital-acquired manifestations of poor glycemic control are commonly readmitted for poor glycemic control, and post-operative infections top the lists of primary reasons for readmissions for patients with SSI HACs.

Table 3a

Five most common principal diagnoses for readmissions within 30 days for discharges with a CMS hospital-acquired condition

Hospital-acquired condition	Most common	Second most common	Third most common	Fourth most common	Fifth most common
Foreign object retained after surgery					
FY 2009 (n=32)	other postoperative infection (n=6)	acute kidney failure (n=2)	—	—	—
FY 2010 (n=27)	other postoperative infection (n=3)	viral enteritis (n=2)	—	—	—
Air embolism					
FY 2009 (n=2)	food/vomit pneumonitis (n=1)	urinary tract infection (n=1)	(none)	(none)	(none)
FY 2010 (n=2)	cerebral artery occlusion w infarction (n=1)	pleural effusion (n=1)	(none)	(none)	(none)
Blood incompatibility					
FY 2009 (n=2)	infection-central venous catheter (n=1)	septicemia (n=1)	(none)	(none)	(none)
FY 2010 (n=2)	pancytopenia (n=1)	viral hepatatitis w/o coma (n=1)	(none)	(none)	(none)
Pressure ulcer stages III and IV					
FY 2009 (n=291)	septicemia (n=33)	pneumonia (n=15)	congestive heart failure (n=14)	pressure ulcer (n=14)	food/vomit pneumonitis (n=13)
FY 2010 (n=286)	septicemia (n=30)	pneumonia (n=14)	acute respiratory failure (n=12)	pressure ulcer (n=11)	food/vomit pneumonitis (n=8)
Falls and trauma					
FY 2009 (n=988)	septicemia (n=56)	pneumonia (n=43)	urinary tract infection (n=34)	congestive heart failure (n=29)	food/vomit pneumonitis (n=26)
FY 2010 (n=822)	pneumonia (n=41)	septicemia (n=39)	urinary tract infection (n=31)	congestive heart failure (n=22)	food/vomit pneumonitis (n=20)

(continued)

Table 3a (continued)
Five most common principal diagnoses for readmissions within 30 days for discharges with a CMS hospital-acquired condition

Hospital-acquired condition	Most common	Second most common	Third most common	Fourth most common	Fifth most common
Catheter-associated UTI					
FY 2009 (n=553)	septicemia (n=39)	acute kidney failure (n=21)	urinary tract infection (n=19)	congestive heart failure (n=17)	pneumonia (n=17)
FY 2010(n=646)	Septicemia (n=50)	pneumonia (n=29)	acute kidney failure (n=23)	urinary tract infection (n=22)	congestive heart failure (n=20)
Vascular catheter-associated infection					
FY 2009 (n=761)	septicemia (n=53)	antineoplastic chemotherapy (n=35)	acute kidney failure (n=23)	infection-central venous catheter (n=23)	other postoperative infection (n=19)
FY 2010 (n=824)	septicemia (n=51)	antineoplastic chemotherapy (n=41)	infection-central veneous catheter (n=34)	pneumonia (n=21)	acute kidney failure (n=19)
Manifestations of poor glycemic control					
FY 2009 (n=62)	congestive heart failure (n=5)	acute on chronic diastolic heart failure (n=4)	diabetes mellitus w ketoacidosis type I uncontrolled (n=4)	food/vomit pneumonitis (n=4)	—
FY 2010 (n=101)	acute kidney failure (n=4)	diabetes mellitus w ketoacidosis type I uncontrolled (n=4)	diabetes mellitus w other specified manifestations Type II (n=4)	pneumonia (n=4)	—
SSSI: mediastinitis, following CABG					
FY 2009 (n=10)	other postoperative infection (n=3)	disruption of external operation wound (n=2)	—	—	—
FY 2010 (n=9)	other postoperative infection (n=3)	—	—	—	—
SSI: certain orthopedic procedures					
FY 2009 (n=32)	other postoperative infection (n=5)	infection and inflammatory reaction due to other internal prosthetic device, implant, and graft (n=2)	—	—	—
FY 2010 (n=38)	other postoperative infection (n=9)	septicemia (n=4)	chest pain (n=2)	—	—

(continued)

Table 3a (continued)
Five most common principal diagnoses for readmissions within 30 days for discharges with a CMS hospital-acquired condition

Hospital-acquired condition	Most common	Second most common	Third most common	Fourth most common	Fifth most common
SSI: bariatric surgery for obesity					
FY 2009 (n=5)	dehydration (n=1)	nausea with vomiting (n=1)	infection-central venous catheter (n=1)	other postoperative infection (n=1)	persistent postoperative fistula (n=1)
FY 2010 (n=2)	other postoperative infection (n=1)	digestive system surgical complications (n=1)	(none)	(none)	(none)
DVT/PE : certain orthopedic procedures					
FY 2009 (n=287)	other postoperative infection (n=12)	hematoma complicating a procedure (n=11)	septicemia (n=10)	pneumonia (n=9)	infection and inflammatory reaction due to internal joint prosthesis (n=8)
FY 2010 (n=221)	infection and inflammatory reaction due to internal joint prosthesis (n=13)	hematoma complicating a procedure (n=10)	other postoperative infection (n=10)	acute kidney failure (n=7)	septicemia (n=7)

NOTES:

1. RTI analysis of live discharges for FY2009 and months 1 through 10 of FY2010 MedPAR data and subsequent readmission for up to a 30-day window.

2. Ties in most common primary diagnosis codes were omitted when the number of ties exceeded the number of spaces remaining in the table; these spaces were left blank.

3. Where there were fewer than 5 most common primary diagnoses, the remaining spaces were labeled “(none).”

Computer run: Readmissions analysis Tables Nov 2011.do.

Table 3b
Five most common principal diagnoses for readmission within 60 days for discharges with a CMS hospital-acquired condition

Hospital-acquired condition	Most common	Second most common	Third most common	Fourth most common	Fifth most common
Foreign object retained after surgery					
FY 2009 (n=47)	other postoperative infection (n=7)	acute kidney failure (n=2)	atrial fibrillation (n=2)	intestinal adhesion w obstruction (n=2)	acute myocardial infarction (n=2)
FY 2010 (n=35)	other postoperative infection (n=3)	septicemia (n=3)	coronary atherosclerosis, of native coronary artery (n=2)	viral enteritis (n=2)	—
Air embolism					
FY 2009 (n=4)	chest pain (n=1)	food/vomit pneumonitis (n=1)	methicillin resistant pneumonia due to staphyloccus aureus (n=1)	urinary tract infection (n=1)	(none)
FY 2010 (n=5)	congestive heart failure (n=1)	cerebral artery occlusion w cerebral infarction (n=1)	pleural effusion (n=1)	other primary cardiomyopathies (n=1)	viral infection (n=1)
Blood incompatibility					
FY 2009 (n=4)	deficiency anemia (n=1)	obstructive chronic bronchitis w acute exacerbation (n=1)	infection-central venous catheter (n=1)	septicemia (n=1)	(none)
FY 2010 (n=3)	chronic duodenal ulcer w hemorrhage (n=1)	pancytopenia (n=1)	viral hepatatits w/o coma (n=1)	(none)	(none)
Pressure ulcer stages III and IV					
FY 2009 (n=395)	septicemia (n=45)	pressure ulcer, low back (n=20)	food/vomit pneumonitis (n=18)	congestive heart failure (n=17)	pneumonia (n=16)
FY 2010 (n=382)	septicemia (n=43)	acute respiratory failure (n=16)	pneumonia (n=15)	pressure ulcer, low back (n=15)	urinary tract infection (n=14)
Falls and trauma					
FY 2009 (n=1,378)	septicemia (n==77)	pneumonia (n=63)	urinary tract infection (n=45)	congestive heart failure (n=40)	obstructive chronic bronchitis w acute exacerbation (n=38)
FY 2010 (n=1,197)	pneumonia (n=58)	septicemia (n=55)	congestive heart failure (n=38)	urinary tract infection (n=36)	obstructive chronic bronchitis w acute exacerbation (n=30)

(continued)

Table 3b (continued)
Five most common principal diagnoses for readmission within 60 days for discharges with a CMS hospital-acquired condition

Hospital-acquired condition	Most common	Second most common	Third most common	Fourth most common	Fifth most common
Catheter-associated UTI					
FY 2009 (n=790)	septicemia (n=46)	urinary tract infection (n=43)	congestive heart failure (n=26)	acute kidney failure (n=25)	pneumonia (n=24)
FY 2010(n=882)	septicemia (n=64)	pneumonia (n=39)	urinary tract infection (n=32)	acute kidney failure (n=27)	congestive heart failure (n=27)
Vascular catheter-associated infection					
FY 2009 (n=1,051)	septicemia (n=71)	antineoplastic chemotherapy (n=41)	infection-central venous catheter (n=33)	acute kidney failure (n=32)	intestinal infection clostridium difficile (n=25)
FY 2010 (n=1,136)	septicemia (n=75)	antineoplastic chemotherapy (n=50)	infection-central venous catheter (n=45)	pneumonia (n=27)	acute kidney failure (n=24)
Manifestations of poor glycemic control					
FY 2009 (n=128)	congestive heart failure (n=6)	septicemia (n=6)	acute on chronic diastolic heart failure (n=5)	diabetes mellitus w ketoacidosis type I uncontrolled (n=5)	pneumonia (n=5)
FY 2010 (n=133)	diabetes mellitus w ketoacidosis type I uncontrolled (n=7)	pneumonia(n=5)	acute kidney failure (n=4)	diabetes mellitus w other specified manifestations type II (n=4)	septicemia (n=4)
SSSI: mediastinitis, following CABG					
FY 2009 (n=14)	other postoperative infection (n=3)	acute & chronic respiratory failure (n=2)	disruption of external operation wound (n=2)	—	—
FY 2010 (n=11)	other postoperative infection (n=3)	—	—	—	—

(continued)

Table 3b (continued)
Five most common principal diagnoses for readmission within 60 days for discharges with a CMS hospital-acquired condition

Hospital-acquired condition	Most common	Second most common	Third most common	Fourth most common	Fifth most common
SSI: certain orthopedic procedures					
FY 2009 (n=42)	other postoperative infection (n=7)	pneumonia (n=2)	infection and inflammatory reaction due to other internal prosthetic device, implant, and graft (n=2)	urinary tract infection (n=2)	—
FY 2010 (n=51)	other postoperative infection (n=9)	septicemia (n=4)	chest pain (n=3)	intestinal infection clostridium difficile (n=2)	pulmonary embolism and infarction (n=2)
SSI: bariatric surgery for obesity					
FY 2009 (n=7)	blood in stool (n=1)	dehydration (n=1)	nausea with vomiting (n=1)	infection-central venous catheter (n=1)	other postoperative infection (n=1)
FY 2010 (n=3)	other postoperative infection (n=1)	septicemia (n=1)	digestive system surgical complications (n=1)	(none)	(none)
DVT/PE : certain orthopedic procedures					
FY 2009 (n=380)	other postoperative infection (n=18)	infection and inflammatory reaction due to internal joint prosthesis (n=16)	hematoma complicating a procedure (n=13)	pneumonia (n=12)	septicemia (n=12)
FY 2010 (n=317)	infection and inflammatory reaction due to internal joint prosthesis (n=19)	other postoperative infection (n=12)	septicemia (n=12)	pneumonia (n=11)	hematoma complicating a procedure (n=10)

NOTES:

1. RTI analysis of live discharges for FY2009 and months 1 through 10 of FY2010 MedPAR data and subsequent readmission for up to a 60-day window.
2. Ties in most common primary diagnosis codes were omitted when the number of ties exceeded the number of spaces remaining in the table; these spaces were left blank.
3. Where there were fewer than 5 most common primary diagnoses, the remaining spaces were labeled "(none)."

Computer run: Readmissions analysis Tables Nov 2011.do.

SECTION 4
READMISSION COMPARISONS: THREE STUDY HACS

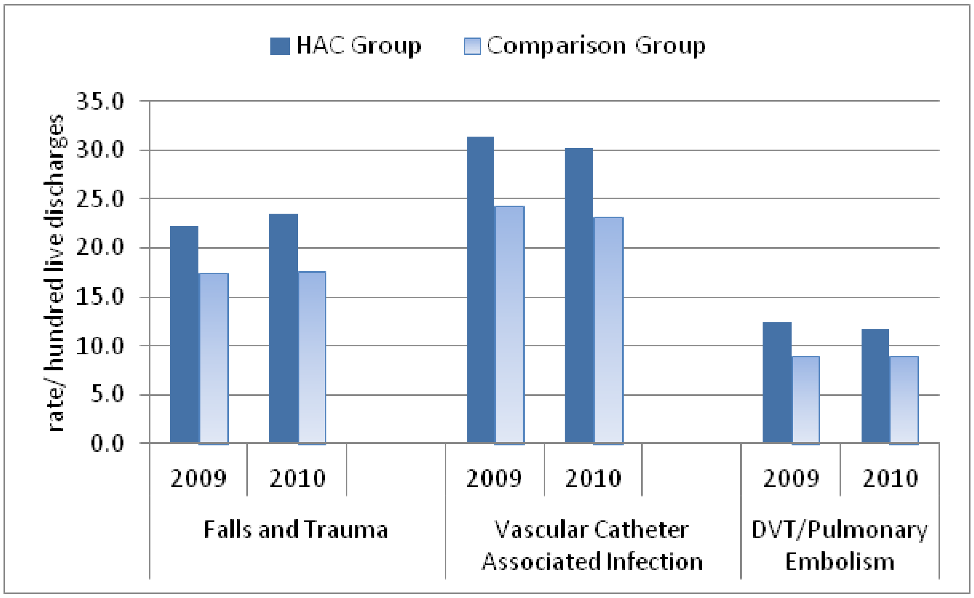
4.1 Readmission Rates for HACs and their Comparison Groups

In this section, we review the findings from further analyses of discharges with falls and trauma, vascular-catheter associated infections, and DVT/PE following certain orthopedic procedures. All observations discharged alive with one of these three HACs were matched up to approximately 10 comparison observations according to the matching criteria described in **Section 2.4**. Where we were not able to obtain a 10:1 match, the matches were weighted to simulate a 10:1 match. In the tables and figures below, we examine differences in all-cause readmission rates between the three study HACs and their comparison groups, for the full study period and also separately by year. We also stratify the data to examine differences by beneficiary demographic characteristics and hospital characteristics. We statistically test for differences in readmission rates between the HAC and comparison groups, in total, and within stratum of characteristic using a negative binomial regression model with robust standard errors.

We compare the readmission rates in FY 2009 and FY 2010 for the three study HACs and for their matched comparisons in **Figure 2**. Frequencies and other statistics underlying this figure are provided in **Table 4**. For all three HAC groups, the 30-day all-cause readmission rates are significantly higher than for their respective comparison groups. Patients with vascular catheter associated infections have the highest rates of readmission; more than 30 out of every 100 of the HAC patients are readmitted to a hospital within 30 days after their index discharge. Compare this to the 23-24 out of 100 the matched comparison patients who have at least one readmission within 30 days. Patients with DVT/PE HACs have the lowest rate of 30-day readmissions: roughly 12 per 100 live discharges. However, for the matched non-HAC patients with the same orthopedic procedures, the readmission rate for the HAC patients is only 9 per 100 live discharges.

Between FY 2009 and FY 2010, the rate of readmission increased (not significantly) for the falls and trauma HAC, but remained stable for its comparison group. For the vascular catheter-associated infection HAC and comparison group, there was a slight decline in readmission rates over time; for the DVT/PE HAC and comparison group, there was little change in the readmission rates between FY 2009 and FY 2010. Keep in mind that year-to-year volatility in rates is to be expected in these statistics, and we will need to see several years of data before we can assess any trends.

Figure 2
Readmission rates by year for discharges with HACs and their comparison groups for three CMS hospital-acquired conditions
(30-day all-cause readmission)



NOTES:

1. Data on live discharges not POA (HAC group) from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

Table 4
Difference in 30-day all-cause readmission rates between the HAC and comparison groups for three CMS hospital-acquired conditions

Hospital-acquired condition	HAC group: Number of live discharges not POA	HAC group: Number of patients with at least 1 readmit	HAC group: Rate per 100 live discharges	Comparison group: Number of live discharges not POA	Comparison group: Number with at least 1 readmit	Comparison group: Rate per 100 live discharges	Difference in Rates
FY 2009							
Falls and trauma	4,449	988	22.2	44,370	7,741	17.4	4.8**
Vascular catheter-associated infection	2,434	761	31.3	22,990	5,588	24.3	7.0**
DVT and pulmonary embolism following certain orthopedic procedures	2,321	287	12.4	23,150	2,064	8.9	3.5**
FY 2010							
Falls and trauma	3,505	822	23.5	34,980	6,188	17.7	5.8**
Vascular catheter-associated infection	2,733	824	30.2	26,000	6,035	23.2	7.0**
DVT and pulmonary embolism following certain orthopedic procedures	1,874	221	11.8	18,710	1,678	9.0	2.8**
Change 2009 to 2010							
Falls and trauma	—	—	1.2	—	—	0.2	—
Vascular catheter-associated infection	—	—	–1.1	—	—	–1.1*	—
DVT and pulmonary embolism following certain orthopedic procedures	—	—	–0.6	—	—	0.1	—

NOTES:

1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.
3. * indicates statistically significant difference using negative binomial regression with $p<0.05$. **indicates statistically significant difference using negative binomial regression with $p<0.01$.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

In the three panels of **Table 5**, we combine the data for FY 2009 and FY 2010 and report the readmission rates for the HAC patients and for the matched comparison groups, stratified by selected beneficiary characteristics. These beneficiary characteristics include age, Medicaid participation, original reason for Medicare eligibility, gender, race, HCC score (calculated using 6 months of Medicare data immediately prior to the index admission), and residence in a nursing facility. Across virtually all of the beneficiary characteristics, with the exception of residence in a nursing home, beneficiaries who had a hospital-acquired condition had a higher likelihood of readmission than comparison group beneficiaries within each stratum. And, the patterns were generally the same in both groups with respect to the characteristics that exhibited higher rates of readmission. Beneficiaries under 65 and over 85 have higher than average readmission rates, as do those who are enrolled in Medicaid, who are disabled, and who have end-stage renal disease (ESRD). Patients with higher HCC scores also have higher readmission rates.

Table 5
HAC vs. comparison group all-cause readmission rates by beneficiary characteristics for three CMS hospital-acquired conditions
(30-day all-cause readmissions, FY 2009-FY 2010)

	5A: Falls and trauma				
	HAC group			Comparison group	
Beneficiary characteristics	Number of live discharges not POA	Number of patients with at least 1 readmission	Rate per 100 live discharges	Rate per 100 live discharges	Difference in rates between HAC and comparison
All	7,954	1,810	22.8	17.6	5.2**
By Age:					
<65	803	215	26.8	20.4	6.4**
65-74	2,038	441	21.6	16.1	5.5**
75-84	2,965	668	22.5	17.2	5.3**
85+	2,148	486	22.6	18.4	4.3**
By Medicaid Status:					
Not Enrolled	6,347	1,367	21.5	16.6	5.0**
Enrolled	1,607	443	27.6	21.5	6.1**
By Original Eligibility:					
Disabled	1,567	399	25.5	19.5	5.9**
Aged	6,261	1,356	21.7	16.8	4.9**
ESRD	126	55	43.7	31.7	12.0**
By Gender:					
Male	2,798	707	25.3	19.3	5.9**
Female	5,156	1,103	21.4	16.6	4.8**
By Race:					
White	7,190	1,632	22.7	17.3	5.4**
African American/Black	440	99	22.5	21.3	1.2
Asian	66	12	18.2	18.7	–0.5
Other	258	67	26.0	18.6	7.4**
By Concurrent HCC Score (6 months prior to Admission):					
Low	2,569	364	14.2	12.2	2.0**
Medium	3,926	924	23.5	21.3	2.3**
High	1,459	522	35.8	31.4	4.4**
By Nursing Home Residency:					
Institutionalized	61	12	19.7	35.2	–15.5
Not Institutionalized	7,893	1,798	22.8	17.6	5.2**

NOTES:

1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.
3. * indicates statistically significant difference using negative binomial regression with $p<0.05$. **indicates statistically significant difference using negative binomial regression with $p<0.01$.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

Table 5 (continued)
HAC vs. comparison group all-cause readmission rates by beneficiary characteristics for three CMS hospital-acquired conditions
(30-day all-cause readmissions, FY 2009-FY 2010)

Beneficiary characteristics	5B: Catheter-associated infections				
	HAC group			Comparison group	Difference in rates between HAC and comparison
	Number of live discharges not POA	Number of patients with at least 1 Readmission	Rate per 100 live discharges	Rate per 100 live discharges	
All	5,167	1,585	30.7	23.7	7.0**
By Age:					
<65	1,605	549	34.2	27.2	7.0**
65-74	1,585	507	32.0	23.6	8.4**
75-84	1,449	400	27.6	21.9	5.7**
85+	528	129	24.4	19.0	5.5**
By Medicaid Status:					
Not Enrolled	3,489	1,004	28.8	22.2	6.6**
Enrolled	1,678	581	34.6	26.7	8.0**
By Original Eligibility:					
Disabled	1,918	637	33.2	25.5	7.7**
Aged	2,933	832	28.4	21.7	6.7**
ESRD	316	116	36.7	31.1	5.6*
By Gender:					
Male	2,311	686	29.7	23.5	6.2**
Female	2,856	899	31.5	23.9	7.6**
By Race:					
White	3,836	1,142	29.8	23.0	6.8**
African American/Black	1,021	325	31.8	26.7	5.1**
Asian	55	18	32.7	28.6	4.1
Other	255	100	39.2	22.8	16.5*
By Concurrent HCC Score (6 months prior to Admission):					
Low	934	208	22.3	18.0	4.3**
Medium	2,044	578	28.3	24.3	3.9**
High	2,189	799	36.5	31.1	5.4**
By Nursing Home Residency:					
Institutionalized	16	4	25.0	25.6	–0.6
Not Institutionalized	5,151	1,581	30.7	23.7	7.0**

NOTES:

1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.
3. * indicates statistically significant difference using negative binomial regression with p<0.05. **indicates statistically significant difference using negative binomial regression with p<0.01.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

Table 5 (continued)
HAC vs. comparison group all-cause readmission rates by beneficiary characteristics for three CMS hospital-acquired conditions
(30-day all-cause readmissions, FY 2009-FY 2010)

	5C: DVT/pulmonary embolism following certain orthopedic procedures				
	HAC group			Comparison group	
Beneficiary characteristics	Number of live discharges not POA	Number of patients with at least 1 readmission	Rate per 100 live discharges	Rate per 100 live discharges	Difference in rates between HAC and comparison
All	4,195	508	12.1	8.9	3.2**
By Age:					
<65	239	35	14.6	9.6	5.1*
65-74	1,862	164	8.8	6.3	2.5**
75-84	1,582	224	14.2	9.9	4.2**
85+	512	85	16.6	14.6	2.0
By Medicaid Status:					
Not Enrolled	3,774	443	11.7	8.4	3.3**
Enrolled	421	65	15.4	12.6	2.8
By Original Eligibility:					
Disabled	525	77	14.7	10.4	4.3**
Aged	3,661	430	11.7	8.6	3.1**
ESRD	9	1	11.1	22.1	–11.0
By Gender:					
Male	1,390	183	13.2	10.3	2.9**
Female	2,805	325	11.6	8.3	3.3**
By Race:					
White	3,760	446	11.9	8.9	3.0**
African American/Black	307	43	14.0	9.9	4.1*
Asian	27	7	25.9	8.2	17.7**
Other	101	12	11.9	8.4	3.5
By Concurrent HCC Score (6 months prior to Admission):					
Low	2,841	295	10.4	7.2	3.2**
Medium	1,237	186	15.0	16.2	–1.1
High	117	27	23.1	24.6	–1.6
By Nursing Home Residency:					
Institutionalized	6	0	0.0	47.4	–47.4
Not Institutionalized	4,189	508	12.1	8.9	3.2**

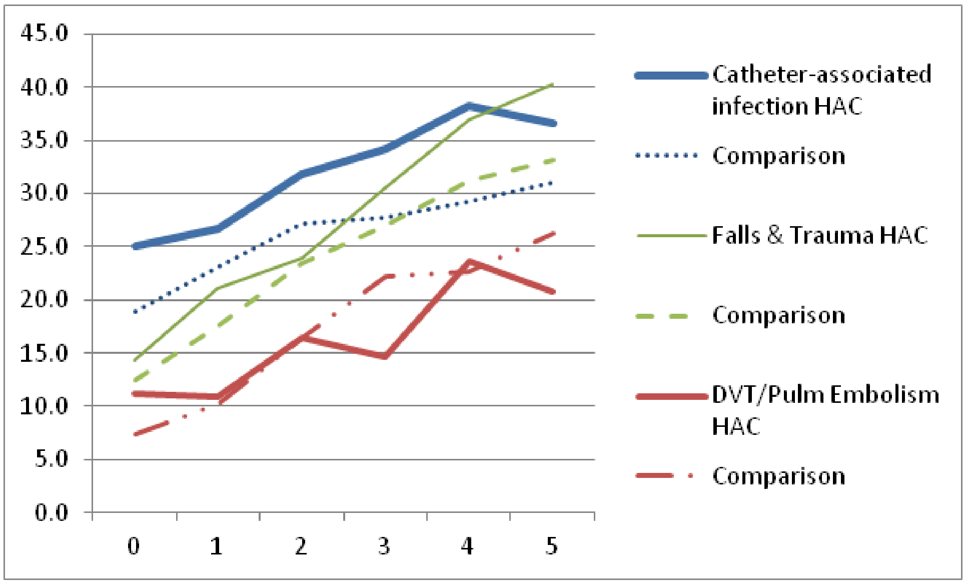
NOTES:

1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.
3. * indicates statistically significant difference using negative binomial regression with $p<0.05$. **indicates statistically significant difference using negative binomial regression with $p<0.01$.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

We also consider how the number of chronic conditions a patient has affects their readmission rates. The presence of chronic conditions is determined from billed diagnoses during the 6 months prior to their index admission. The chronic conditions include congestive heart failure, heart arrhythmia, renal failure, chronic obstructive pulmonary disorder, diabetes without complications, diabetes with complications, vascular disease, and cancer. In **Figure 3**, we graph the relationship between the number of chronic conditions and the readmission rate, separately for each of the three study HACs and their comparison groups.

Figure 3
Number of chronic conditions and rate of readmission for three CMS hospital-acquired conditions



NOTES:

1. RTI analysis of live discharges for FY2009 and months 1 through 10 of FY2010 MedPAR data and subsequent readmission for up to a 30-day window.

2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.

3. The number of chronic conditions is capped at 5, so patients with more than 5 chronic conditions are included with those who have 5.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

As we would expect, more chronic conditions are correlated with higher readmission rates. The rate of readmission increases as the number of chronic conditions increase in both the HAC and comparison groups although there is less of a pattern in the patients with HACs having consistently higher rates of readmission than the comparison groups.

In the three panels of **Table 6**, we combine the data for FY 2009 and FY 2010 and report the readmission rates for the HAC patients and for the matched comparison groups, stratified by selected hospital characteristics. These hospital characteristics include Census region, urban or rural location, academic medical centers, and the number of beds. As with beneficiary characteristics, we conduct statistical testing between the HAC and comparison groups within stratum of characteristics. Beneficiaries with HACs are more likely than comparison group patients to be readmitted within all strata of hospital characteristics.

Table 6
HAC vs. comparison group all-cause readmission rates by hospital characteristics for three CMS hospital-acquired conditions
(30-day all-cause readmissions, FY 2009-FY 2010)

	6A: Falls and trauma				
	HAC group			Comparison group	
Hospital characteristics	Number of live discharges not POA	Number of patients with at least 1 readmission	Rate per 100 live discharges	Rate per 100 live discharges	Difference in rates between HAC and comparison
All	7,954	1,810	22.8	17.6	5.2**
By Census Division:					
New England	400	92	23.0	17.6	5.4**
Mid-Atlantic	1,188	309	26.0	19.8	6.2**
East North Central	1,332	300	22.5	18.6	3.9**
West North Central	569	116	20.4	16.3	4.0*
South Atlantic	1,647	408	24.8	17.5	7.3**
East South Central	705	158	22.4	17.7	4.7**
West South Central	955	203	21.3	16.4	4.8**
Mountain	446	86	19.3	15.2	4.1*
Pacific	703	137	19.5	15.7	3.8**
By Urbanicity:					
Urban	6,648	1,522	22.9	17.7	5.2**
Rural	1,306	288	22.1	16.8	5.3**
By Teaching Status:					
Academic Medical Center	571	144	25.2	19.9	5.4**
Other	7,383	1,666	22.6	17.4	5.2**
By Hospital Beds:					
<100	939	202	21.5	15.4	6.1**
100-299	2,914	673	23.1	17.3	5.8**
300+	4,101	935	22.8	18.1	4.7**

NOTES:
1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.
3. * indicates statistically significant difference using negative binomial regression with $p<0.05$. **indicates statistically significant difference using negative binomial regression with $p<0.01$.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

Table 6 (continued)
HAC vs. comparison group all-cause readmission rates by hospital characteristics for three CMS hospital-acquired conditions
(30-day all-cause readmissions, FY 2009-FY 2010)

	6B: Catheter-associated infections				
	HAC group			Comparison group	
Hospital characteristics	Number of live discharges not POA	Number of patients with at least 1 readmission	Rate per 100 live discharges	Rate per 100 live discharges	Difference in rates between HAC and comparison
All	5,167	1,585	30.7	23.7	7.0**
By Census Division:					
New England	262	88	33.6	24.3	9.3**
Mid-Atlantic	900	289	32.1	25.6	6.6**
East North Central	781	243	31.1	25.6	5.5**
West North Central	293	92	31.4	23.8	7.6**
South Atlantic	1,054	319	30.3	23.2	7.1**
East South Central	335	112	33.4	24.7	8.8**
West South Central	732	207	28.3	21.3	7.0**
Mountain	246	66	26.8	20.8	6.0*
Pacific	551	162	29.4	23.5	5.9**
By Urbanicity:					
Urban	4,751	1,463	30.8	24.0	6.8**
Rural	416	122	29.3	20.8	8.5**
By Teaching Status:					
Academic Medical Center	778	297	38.2	26.5	11.7**
Other	4,389	1,288	29.3	23.4	6.0**
By Hospital Beds:					
<100	228	61	26.8	21.7	5.1
100-299	1,521	426	28.0	22.8	5.2**
300+	3,418	1,098	32.1	24.4	7.7**

NOTES:

1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.

2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.

3. * indicates statistically significant difference using negative binomial regression with $p<0.05$. **indicates statistically significant difference using negative binomial regression with $p<0.01$.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

Table 6 (continued)
HAC vs. comparison group all-cause readmission rates by hospital characteristics for three CMS hospital-acquired conditions
(30-day all-cause readmissions, FY 2009-FY 2010)

	6C: DVT/pulmonary embolism following certain orthopedic procedures				
	HAC group			Comparison group	
Hospital characteristics	Number of live discharges not POA	Number of patients with at least 1 readmission	Rate per 100 live discharges	Rate per 100 live discharges	Difference in rates between HAC and comparison
All	4,195	508	12.1	8.9	3.2**
By Census Division:					
New England	230	36	15.7	9.3	6.4**
Mid-Atlantic	652	73	11.2	9.6	1.6
East North Central	915	114	12.5	9.1	3.3**
West North Central	329	26	7.9	8.7	–0.8
South Atlantic	823	98	11.9	9.6	2.3*
East South Central	244	31	12.7	9.6	3.1
West South Central	367	50	13.6	8.8	4.8**
Mountain	272	30	11.0	7.7	3.3
Pacific	360	50	13.9	6.9	7.0**
By Urbanicity:					
Urban	3,787	464	12.3	8.9	3.4**
Rural	408	44	10.8	9.4	1.3
By Teaching Status:					
Academic Medical Center	413	68	16.5	9.0	7.5**
Other	3,782	440	11.6	8.9	2.7**
By Hospital Beds:					
<100	373	37	9.9	6.9	3.1*
100-299	1,379	158	11.5	9.2	2.2**
300+	2,443	313	12.8	9.2	3.6**

NOTES:

1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.

2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.

3. * indicates statistically significant difference using negative binomial regression with p<0.05. **indicates statistically significant difference using negative binomial regression with p<0.01.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

4.2 Reasons for Readmissions for HACs and their Comparison Groups

In **Table 7**, we list the top five most common principal diagnoses that occur on the first readmission within a 30-day follow-up period for the three HACs and their comparison groups. The top five principal diagnosis codes are listed separately for FY 2009 and FY 2010. There is not much change in the most common principal diagnoses between FY 2009 and FY 2010, looking within each of the three HACs or their comparison groups. Each list shares at least three, if not four or five, of the most common principal diagnoses. Therefore, we do not detect any substantive changes in the reasons for readmissions between FY 2009 and FY 2010.

Additionally, the primary reasons for readmission are fairly similar between the HACs and their matched comparison groups. While the rates of readmission for the HAC patients are much higher than for their comparisons, we find many of the same reasons for readmission. For example, among falls and trauma patients who are readmitted after the HAC, four of the five top reasons for readmission - septicemia, pneumonia, urinary tract infection, and congestive heart failure – are shared by the falls and trauma comparison patients (who have not had a fall or trauma). One noticeable exception, patients who have had a hospital-acquired vascular catheter associated infection have “infection of a central venous catheter” in their top five reasons for readmission, while their matched comparisons do not have this as a common reason for readmission. Overall, we find similar patterns in the reasons for readmissions among the HAC patients and their comparison groups.

Table 7
Differences in reasons for all-cause readmission between HACs and comparison groups for three CMS hospital-acquired conditions

Hospital-acquired condition	Principal diagnosis on first all-cause readmission within 30 days				
	Most common	Second most common	Third most common	Fourth most common	Fifth most common
Falls & Trauma					
HAC Group:					
FY 2009 (n=988)	septicemia (n=56)	pneumonia (n=43)	urinary tract infection (n=34)	congestive heart failure (n=29)	food/vomit pneumonitis (n=26)
FY 2010 (n=822)	pneumonia (n=41)	septicemia (n=39)	urinary tract infection (n=31)	congestive heart failure (n=22)	food/vomit pneumonitis (n=20)
Comparison Group:					
FY 2009 (n=7,741)	septicemia (n=271)	pneumonia (n=206)	congestive heart failure (n=198)	urinary tract infection (n=197)	obstructive chronic bronchitis w acute exacerbation (n=178)
FY 2010 (n=6,188)	septicemia (n=280)	pneumonia (n=218)	acute kidney failure (n=169)	urinary tract infection (n=149)	congestive heart failure (n=148)
Vascular catheter-associated infection					
HAC Group:					
FY 2009 (n=761)	septicemia (n=53)	antineoplastic chemotherapy (n=35)	acute kidney failure (n=23)	infection-central venous catheter (n=23)	other postoperative infection (n=19)
FY 2010 (n=824)	septicemia (n=51)	antineoplastic chemotherapy (n=41)	infection-central veneous catheter (n=34)	pneumonia (n=21)	acute kidney failure (n=19)
Comparison Group:					
FY 2009 (n=5,588)	septicemia (n=270)	acute kidney failure (n=125)	antineoplastic chemotherapy (n=125)	pneumonia (n=111)	other postoperative infection (n=106)
FY 2010 (n=6,035)	septicemia (n=342)	pneumonia (n=137)	acute kidney failure (n=119)	acute respiratory failure (n=113)	congestive heart failure (n=100)

(continued)

Table 7 (continued)
Differences in reasons for all-cause readmission between HACs and comparison groups for three CMS hospital-acquired conditions

Hospital-acquired condition	Principal diagnosis on first all-cause readmission within 30 days: Most common	Second most common	Third most common	Fourth most common	Fifth most common
DVT/ pulmonary embolism following certain orthopedic procedures					
HAC Group:					
FY 2009 (n=287)	other postoperative infection (n=12)	hematoma complicating a procedure (n=11)	septicemia (n=10)	pneumonia (n=9)	infection and inflammatory reaction due to internal joint prosthesis (n=8)
FY 2010 (n=221)	infection and inflammatory reaction due to internal joint prosthesis (n=13)	hematoma complicating a procedure (n=10)	other postoperative infection (n=10)	acute kidney failure (n=7)	septicemia (n=7)
Comparison Group:					
FY 2009 (n=2,064)	other postoperative infection (n=95)	infection and inflammatory reaction due to internal joint prosthesis (n=81)	dislocation of prosthetic joint (n=68)	urinary tract infection (n=59)	septicemia (n=55)
FY 2010 (n=1,678)	dislocation of prosthetic joint (n=79)	other postoperative infection (n=66)	pneumonia (n=64)	septicemia (n=60)	infection and inflammatory reaction due to internal joint prosthesis (n=60)

NOTES:
1. RTI analysis of live discharges for FY2009 and months 1-10 of FY2010 MedPAR data and subsequent readmission for up to a 30-day window.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

4.3 The Effect of Using the Yale Definition of "Unplanned" Re-admissions

We examined whether using the Yale definition of unplanned readmissions along with a set of discharge exclusions had an impact on the results found in **Sections 4.1** and **4.2**. In **Table 8**, we present new readmission rate calculations, using the 30-day "unplanned" readmission definition. The numbers in this table can be directly compared to those in **Table 4** where we used the 30-day all-cause readmission definition. Applying the new set of discharge exclusions generally decreased the sample of live discharges in both the HAC and comparison groups by roughly 10 percent for the DVT/PE following certain orthopedic procedures HAC, by roughly 23 percent for the falls and trauma HAC, and by roughly 50 percent for the vascular catheter-associated infection HAC.

After removing the "planned" admissions, readmission rates were also slightly lower than in our analyses of 30-day all-cause readmissions. The declines in readmission rates were generally similar for both the HAC and comparison groups. Comparing FY 2009/FY 2010 readmission rates between **Table 4** (all-cause) and **Table 8** (unplanned) reveals lower unplanned rates ranging only from less than 1 percentage point to 3 percentage points. Because, the decreases in the readmission rates were of similar magnitudes across the HAC and comparison groups, the differences in the readmission rates between the two groups across all three HACs were minimal.

In **Tables 9** and **10**, we present comparisons of readmission rates for both the HAC and comparison groups stratified by beneficiary and hospital characteristics. The results in these tables are directly comparable to those in **Tables 5** and **6**. When looking at differences in readmission rates between the HAC and comparison groups across beneficiary and hospital characteristics, the results using the Yale definition are quite similar to the results using the original all-cause definition. The magnitudes in the differences in readmission rates between the HAC and comparison groups are similar and in the same direction. The qualitative result, that the HAC groups had higher readmission rates than the comparison groups across the various beneficiary and hospital characteristics, was the same regardless of which readmission definition we used.

Finally, the top reasons for readmission are quite robust to the definition of readmission used. Using the Yale 30-day "unplanned" readmission definition, we determined the top five reasons for readmission. The results are reported in **Table 11** and can be compared with the top five reasons for readmission reported in **Table 7**. In nine out of the 12 instances, at least four out of the five top reasons were the same regardless of which readmission definition used. In the one case where only two of the top five reasons were common to both definitions (the DVT/PE following certain orthopedic procedures HAC group in FY 2009), the two in-common reasons were the top two reasons in each case.

Our overall assessment is that using the Yale definition of "unplanned" readmissions would have no significant effect on the results reported in **Sections 4.1** and **4.2**. The readmission rates are slightly lower using the Yale definition, which would be expected. At the same time, the results regarding the differences in readmission rates between the HAC and comparison groups are basically unchanged and the results regarding the top reasons for readmission are very similar.

Table 8
Difference in 30-day unplanned readmission rates between the HAC and comparison groups for three CMS hospital-acquired conditions

	HAC group			Comparison group			
Hospital-acquired condition	Number of live discharges not POA	Number of patients with at least 1 readmit	Rate per 100 live discharges	Number of live discharges not POA	Number with at least 1 readmit	Rate per 100 live discharges	Difference in rates
FY 2009							
Falls and trauma	3,453	663	19.2	34,400	5,439	15.8	3.4**
Vascular catheter-associated infection	1,219	344	28.2	11,830	2,568	21.7	6.5**
DVT and pulmonary embolism following certain orthopedic procedures	2,156	252	11.7	21,500	1,782	8.3	3.4**
FY 2010							
Falls and trauma	2,665	575	21.6	26,610	4,263	16.0	5.6**
Vascular catheter-associated infection	1,373	364	26.5	13,400	2,809	21.0	5.5**
DVT and pulmonary embolism following certain orthopedic procedures	1,705	183	10.7	14,960	1,248	8.3	2.4**
Change 2009 to 2010							
Falls and trauma	—	—	2.4*	—	—	0.2	—
Vascular catheter-associated infection	—	—	–1.7	—	—	–0.7	—
DVT and pulmonary embolism following certain orthopedic procedures	—	—	–1.0	—	—	0.1	—

NOTES:
1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.
3. * indicates statistically significant difference using negative binomial regression with p<0.05. **indicates statistically significant difference using negative binomial regression with p<0.01.SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

Table 9
HAC vs. comparison group unplanned readmission rates by beneficiary characteristics for three CMS hospital-acquired conditions
(30-day all-cause readmissions, FY 2009-FY 2010)

	5A: Falls and trauma				
	HAC group			Comparison group	
Beneficiary characteristics	Number of live discharges not POA	Number of patients with at least 1 readmission	Rate per 100 live discharges	Rate per 100 live discharges	Difference in rates between HAC and comparison
All	6,118	1,238	20.2	15.9	4.3**
By Age:					
65-74	1,796	361	20.1	13.7	6.4**
75-84	2,546	511	20.1	15.3	4.8**
85+	1,776	366	20.6	16.5	4.1**
By Medicaid Status:					
Not Enrolled	5,105	964	18.9	14.4	4.5**
Enrolled	1,013	274	27.0	19.2	7.9**
By Original Eligibility:					
Disabled	744	183	24.6	17.3	7.3**
Aged	5,352	1,045	19.5	14.8	4.7**
ESRD	22	10	45.5	34.9	10.6
By Gender:					
Male	1,994	462	23.2	16.7	6.4**
Female	4,124	776	18.8	14.4	4.4**
By Race:					
White	5,603	1,124	20.1	15.0	5.1**
African American/Black	289	60	20.8	18.3	2.5
Asian	48	7	14.6	16.0	–1.5
Other	178	47	26.4	16.2	10.2**
By Concurrent HCC Score (6 months prior to Admission):					
Low	2,138	269	12.6	10.4	2.2**
Medium	3,063	659	21.5	19.1	2.4**
High	917	310	33.8	29.5	4.3**
By Nursing Home Residency:					
Institutionalized	53	9	17.0	39.8	–22.8
Not Institutionalized	6,065	1,229	20.3	15.1	5.1**

NOTES:

1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.
3. * indicates statistically significant difference using negative binomial regression with $p<0.05$. **indicates statistically significant difference using negative binomial regression with $p<0.01$.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

Table 9 (continued)
HAC vs. comparison group unplanned readmission rates by beneficiary characteristics for three CMS hospital-acquired conditions
(30-day all-cause readmissions, FY 2009-FY 2010)

	5B: Catheter-associated infections				
	HAC group			Comparison group	Difference in rates between HAC and comparison
Beneficiary characteristics	Number of live discharges not POA	Number of patients with at least 1 readmission	Rate per 100 live discharges	Rate per 100 live discharges	
All	2,592	708	27.3	21.3	6.0**
By Age:					
65-74	1,120	324	28.9	21.3	7.6**
75-84	1,086	281	25.9	20.9	5.0**
85+	386	103	26.7	17.6	9.1**
By Medicaid Status:					
Not Enrolled	1,989	500	25.1	19.4	5.7**
Enrolled	603	208	34.5	24.2	10.3**
By Original Eligibility:					
Disabled	469	144	30.7	23.9	6.8**
Aged	2,091	552	26.4	19.8	6.6**
ESRD	32	12	37.5	25.0	12.5
By Gender:					
Male	1,102	283	25.7	20.4	5.2**
Female	1,490	425	28.5	20.7	7.8**
By Race:					
White	2,063	534	25.9	20.2	5.7**
African American/Black	388	117	30.2	22.7	7.4**
Asian	27	10	37.0	26.4	10.7
Other	114	47	41.2	19.9	21.4**
By Concurrent HCC Score (6 months prior to Admission):					
Low	550	99	18.0	15.7	2.3
Medium	1,055	283	26.8	21.9	4.9**
High	987	326	33.0	27.1	5.9**
By Nursing Home Residency:					
Institutionalized	12	4	33.3	100.0	–66.7
Not Institutionalized	2,580	704	27.3	20.6	6.7**

NOTES:

1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.
3. * indicates statistically significant difference using negative binomial regression with $p<0.05$. **indicates statistically significant difference using negative binomial regression with $p<0.01$.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

Table 9 (continued)
HAC vs. comparison group unplanned readmission rates by beneficiary characteristics for three CMS hospital-acquired conditions
(30-day all-cause readmissions, FY 2009-FY 2010)

	5C: DVT/pulmonary embolism following certain orthopedic procedures				
	HAC group			Comparison group	
Beneficiary characteristics	Number of live discharges not POA	Number of patients with at least 1 readmission	Rate per 100 live discharges	Rate per 100 live discharges	Difference in rates between HAC and comparison
All	3,861	435	11.3	8.3	3.0**
By Age:					
65-74	1,845	154	8.3	5.8	2.6**
75-84	1,548	210	13.6	9.2	4.3**
85+	468	71	15.2	12.8	2.3
By Medicaid Status:					
Not Enrolled	3,554	385	10.8	7.7	3.2**
Enrolled	307	50	16.3	11.8	4.5*
By Original Eligibility:					
Disabled	289	40	13.8	10.5	3.4*
Aged	3,570	395	11.1	7.8	3.2**
ESRD	2	0	0.0	18.8	–18.8
By Gender:					
Male	1,267	149	11.8	9.3	2.4**
Female	2,594	286	11.0	7.4	3.6**
By Race:					
White	3,513	389	11.1	8.0	3.1**
African American/Black	237	32	13.5	9.8	3.7
Asian	25	5	20.0	8.0	12.0*
Other	86	9	10.5	7.0	3.4
By Concurrent HCC Score (6 months prior to Admission):					
Low	2,656	254	9.6	6.6	3.0**
Medium	1,114	162	14.5	14.5	0.0
High	91	19	20.9	23.5	–2.6
By Nursing Home Residency:					
Institutionalized	5	0	0.0	56.3	–56.3
Not Institutionalized	3,856	435	11.3	8.1	3.2**

NOTES:
1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.
3. * indicates statistically significant difference using negative binomial regression with $p<0.05$. **indicates statistically significant difference using negative binomial regression with $p<0.01$.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

Table 10
HAC vs. comparison group unplanned readmission rates by hospital characteristics for three CMS hospital-acquired conditions
(30-day all-cause readmissions, FY 2009-FY 2010)

	6A: Falls and trauma				
	HAC group			Comparison group	
Hospital characteristics	Number of live discharges not POA	Number of patients with at least 1 readmission	Rate per 100 live discharges	Rate per 100 live discharges	Difference in rates between HAC and comparison
By Census Division:					
New England	324	71	21.9	15.7	6.2**
Mid-Atlantic	907	195	21.5	17.5	4.0**
East North Central	1,031	223	21.6	15.9	5.7**
West North Central	426	74	17.4	14.1	3.3*
South Atlantic	1,279	286	22.4	15.0	7.3**
East South Central	526	106	20.2	15.3	4.8**
West South Central	737	127	17.2	14.0	3.3**
Mountain	349	66	18.9	13.2	5.7**
Pacific	532	89	16.7	13.2	3.6**
By Urbanicity:					
Urban	5,107	1,047	20.5	15.2	5.3**
Rural	1,011	191	18.9	14.7	4.2**
By Teaching Status:					
Academic Medical Center	381	81	21.3	16.8	4.5*
Other	5,737	1,157	20.2	15.0	5.1**
By Hospital Beds:					
<100	761	150	19.7	13.6	6.1**
100-299	2,290	482	21.0	15.0	6.1**
300+	3,067	606	19.8	15.6	4.2**

NOTES:

1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.
3. * indicates statistically significant difference using negative binomial regression with p<0.05. **indicates statistically significant difference using negative binomial regression with p<0.01.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

Table 10 (continued)
HAC vs. comparison group unplanned readmission rates by hospital characteristics for three CMS hospital-acquired conditions
(30-day all-cause readmissions, FY 2009-FY 2010)

	6B: Catheter-associated infections				
	HAC group			Comparison group	
Hospital characteristics	Number of live discharges not POA	Number of patients with at least 1 readmission	Rate per 100 live discharges	Rate per 100 live discharges	Difference in rates between HAC and comparison
All	2,592	708	27.3	21.3	6.0**
By Census Division:					
New England	127	34	26.8	20.2	6.5
Mid-Atlantic	489	155	31.7	23.2	8.5**
East North Central	410	122	29.8	21.6	8.2**
West North Central	150	33	22.0	20.7	1.3
South Atlantic	495	139	28.1	21.3	6.8**
East South Central	142	38	26.8	21.1	5.6*
West South Central	360	90	25.0	18.3	6.7**
Mountain	127	26	20.5	16.4	4.1
Pacific	285	68	23.9	19.4	4.5
By Urbanicity:					
Urban	2,389	649	27.2	20.9	6.3**
Rural	203	59	29.1	17.7	11.4**
By Teaching Status:					
Academic Medical Center	305	106	34.8	24.3	10.4**
Other	2,287	602	26.3	20.3	6.1**
By Hospital Beds:					
<100	130	35	26.9	18.2	8.7**
100-299	809	213	26.3	19.8	6.5**
300+	1,653	460	27.8	21.3	6.5**

NOTES:

1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.
3. * indicates statistically significant difference using negative binomial regression with $p<0.05$. **indicates statistically significant difference using negative binomial regression with $p<0.01$.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

Table 10 (continued)
HAC vs. comparison group unplanned readmission rates by hospital characteristics for three CMS hospital-acquired conditions
(30-day all-cause readmissions, FY 2009-FY 2010)

	6C: DVT/pulmonary embolism following certain orthopedic procedures				
	HAC group			Comparison group	
Hospital characteristics	Number of live discharges not POA	Number of patients with at least 1 readmission	Rate per 100 live discharges	Rate per 100 live discharges	Difference in rates between HAC and comparison
All	3,861	435	11.3	8.3	3.0**
By Census Division:					
New England	212	34	16.0	8.6	7.4**
Mid-Atlantic	613	64	10.4	8.8	1.7
East North Central	838	99	11.8	8.3	3.5**
West North Central	305	20	6.6	7.8	–1.3
South Atlantic	756	81	10.7	8.7	2.0*
East South Central	215	25	11.6	8.7	3.0
West South Central	328	42	12.8	7.9	4.9**
Mountain	252	27	10.7	6.7	4.1*
Pacific	339	43	12.7	6.0	6.7**
By Urbanicity:					
Urban	3,488	399	11.4	8.0	3.4**
Rural	373	36	9.7	8.5	1.2
By Teaching Status:					
Academic Medical Center	373	59	15.8	8.1	7.8**
Other	3,488	376	10.8	8.1	2.7**
By Hospital Beds:					
<100	347	31	8.9	5.9	3.0**
100-299	1,272	132	10.4	8.3	2.0**
300+	2,242	272	12.1	8.3	3.8**

NOTES:

1. Data on live discharges not POA from FY 2009 and the first 10 months of FY 2010; Data on comparison beneficiaries from FY 2009 and the first 9 months of FY 2010.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.
3. * indicates statistically significant difference using negative binomial regression with $p<0.05$. **indicates statistically significant difference using negative binomial regression with $p<0.01$.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

Table 11
Differences in reasons for 30-day unplanned readmissions between HACs and comparison groups for three CMS hospital-acquired conditions

Hospital-acquired condition	Principal diagnosis on first all-cause readmission within 30 days				
	Most common	Second most common	Third most common	Fourth most common	Fifth most common
Falls & Trauma					
HAC Group:					
FY 2009 (n=663)	septicemia (n=30)	pneumonia (n=27)	urinary tract infection (n=26)	congestive heart failure (n=21)	acute kidney failure (n=20)
FY 2010 (n=575)	pneumonia (n=27)	urinary tract infection (n=25)	septicemia (n=23)	congestive heart failure (n=18)	obstructive chronic bronchitis w acute exacerbation (n=17)
Comparison Group:					
FY 2009 (n=5,439)	congestive heart failure (n=148)	urinary tract infection (n=143)	pneumonia (n=137)	obstructive chronic bronchitis w acute exacerbation (n=132)	septicemia (n=121)
FY 2010 (n=4,263)	septicemia (n=144)	pneumonia (n=139)	urinary tract infection (n=112)	acute kidney failure (n=96)	congestive heart failure (n=94)
Vascular catheter-associated infection					
HAC Group:					
FY 2009 (n=344)	septicemia (n=26)	intestinal infection clostridium difficile (n=12)	acute kidney failure (n=11)	congestive heart failure (n=10)	other postoperative infection (n=10)
FY 2010 (n=364)	septicemia (n=20)	infection central venous catheter (n=15)	pneumonia (n=15)	food/vomit pneumonitis (n=11)	urinary tract infection (n=11)
Comparison Group:					
FY 2009 (n=2,568)	septicemia (n=80)	acute kidney failure (n=71)	pneumonia (n=58)	congestive heart failure (n=51)	other postoperative infection (n=51)
FY 2010 (n=2,809)	septicemia (n=135)	acute kidney failure (n=63)	pneumonia (n=58)	congestive heart failure (n=48)	intestinal infection clostridium difficile (n=48)

(continued)

Table 11 (continued)
Differences in reasons for 30-day unplanned readmissions between HACs and comparison groups for three CMS hospital-acquired conditions

Hospital-acquired condition	Principal diagnosis on first all-cause readmission within 30 days: Most common	Second most common	Third most common	Fourth most common	Fifth most common
DVT/ pulmonary embolism following certain orthopedic procedures					
HAC Group:					
FY 2009 (n=252)	other postoperative infection (n=12)	hematoma complicating a procedure (n=11)	atrial fibrillation (n=7)	dislocation of prosthetic joint (n=7)	septicemia (n=7)
FY 2010 (n=183)	infection and inflammatory reaction due to internal joint prosthesis (n=10)	other postoperative infection (n=9)	hematoma complicating a procedure (n=8)	acute kidney failure (n=6)	gastrointestinal hemorrhage (n=6)
Comparison Group:					
FY 2009 (n=1,782)	other postoperative infection (n=81)	infection and inflammatory reaction due to internal joint prosthesis (n=71)	dislocation of prosthetic joint (n=58)	urinary tract infection (n=49)	septicemia (n=40)
FY 2010 (n=1,248)	dislocation of prosthetic joint (n=63)	other postoperative infection (n=59)	pneumonia (n=52)	septicemia (n=46)	infection and inflammatory reaction due to internal joint prosthesis (n=39)

NOTES:

1. RTI analysis of live discharges for FY2009 and months 1 through 10 of FY2010 MedPAR data and first readmission within a 30-day window.
2. Comparison group matched to HAC group on age, sex, race, and MSDRG, and weighted to simulate a 10:1 match.

SOURCE: Readmissions analysis Tables Nov 2011.do and Comparisons Tables Dec 2011.do

SECTION 5
SPECIAL STUDIES

5.1 "Look-backs" on Cases with HAC-associated Diagnoses that were Coded as Present on Admission

In order to help inform the Accuracy of Coding task and provide CMS with information on the likely costs to the Medicare program of complications that occur after discharge but could be plausibly linked to a prior admission, we conducted a separate analysis of the hospital claims in which one of the HAC-associated diagnoses was coded as present on admission (POA). **Table 12** presents the results of this analysis. For each HAC we present the following figures:

- Frequencies of discharges for HAC-associated diagnoses coded as POA;
- Frequencies of a previous hospital discharge within 60 days of the POA admission;
- Frequencies of those previous discharges that have the same condition coded as HAC;
- The percent of the previous discharges that have the condition coded as having been hospital-acquired and
- The proportion of all of the POA claims that have a previous admission with the relevant HAC-associated diagnoses coded as hospital-acquired.

For this sub-analysis, we began with all of the IPPS hospital claims that had at least one of the HAC-associated diagnoses coded as POA. From these "POA claims", we used the cross-referenced HIC number to look back for a period of up to 60 days prior to the admission date for a discharge from a hospital. For each condition, we looked at the diagnosis codes on the previous claims to determine if any of the selected HACs were present. We then applied the same inclusion criteria that were applied to the construction of the episode files for the rest of the analyses (see **Section 1.1**).

Note that we have not included the SSIs or the DVT/PE HACs in this look-back analysis. The most appropriate way in which to analyze POA for these two conditions is to start with the set of hospitalizations that include the relevant surgical procedures, with or without the HAC-associated diagnosis codes, and then to look forward for subsequent hospitalizations with the HAC-associated diagnosis codes. This analysis for the SSIs was completed as a part of the Year 2 Analysis Report: Estimating the Incremental Costs of Hospital-Acquired Conditions (HACs); see **Table 7** and the accompanying discussion in that report for more details.

The first column of **Table 12** shows the frequencies of the HAC-associated diagnoses that are coded as POA in our sample. In the second column, we report how many of the index POA claims were matched with at least one hospital claim within a 60-day window prior to the POA admission. For POA diagnoses where a previous medical encounter of some sort would seem to be necessary for the condition, such as catheter-associated urinary tract infection or vascular catheter-associated infection, there are a higher proportion of matched previous claims, up to 50 percent for the vascular catheter infections (5,496/10,956). Other POA diagnoses, such as falls and trauma or poor glycemic control, are likely to occur without a medical encounter, so there are far fewer identified prior claims.

As was the case in the Phase I analysis, we found virtually no cases where the index POA hospital claim could be matched to a previous hospital claim where the same condition was coded as hospital-acquired within the 60-day look-back window. This is likely due to several factors. For falls and trauma or poor glycemic control, beneficiaries can fall or fail to maintain control of their diabetes in any setting and a hospitalization, or even a medical encounter, would not be necessary for the patient to be assigned the relevant diagnosis code upon admission to a hospital. Limiting our look-backs to other hospital claims misses other medical encounters where the POA condition may have occurred – for example, a patient hospitalized with POA pressure ulcers could have developed them in a nursing facility/skilled nursing facility. Some of the HAC-associated diagnoses, however, could be true HACs that have been miscoded as POA. Identifying this problem requires a more detailed investigation that looks back for all health care encounters in the inpatient, outpatient or nursing home environments, and, as previously described, for the SSIs or the DVT/PE HAC; it requires looking back for prior surgical encounters rather than prior HAC diagnoses.

Table 12
Prior hospitalizations for beneficiaries where HAC-associated diagnoses were coded as present-on-admission

	60-day look-back period				
Hospital-acquired conditions not restricted to certain surgical procedures	Number of discharges with HAC-associated diagnoses coded POA	Number identified with at least one previous discharge within 60 days of admission	Number of previous discharges with the same condition coded as a HAC	Percent of previous discharges with the HAC identified	Percent of POA observations with the HAC identified in a previous discharge
Foreign object retained after surgery	380	140	0	0.0%	0.0%
Air embolism	21	5	0	0.0%	0.0%
Blood incompatibility	43	19	0	0.0%	0.0%
Pressure ulcer stages III and IV	222,166	123,621	395	0.3%	0.2%
Falls and trauma	302,852	63,501	302	0.5%	0.1%
Catheter-associated urinary tract infection	28,335	14,555	43	0.3%	0.2%
Vascular catheter-associated infection	10,956	7,461	91	1.2%	0.8%
Manifestations of poor glycemic control	30,862	9,605	21	0.2%	0.1%
Total	595,615	218,907	852	0.4%	0.1%

NOTES:

1. RTI analysis of live discharges for FY2009 and months 1 through 10 of FY2010 MedPAR data and previous admissions for up to a 60-day window.

SOURCE: Readmissions analysis Tables Nov 2011.do.

5.2 Timing to Clinical Presentation of Mediastinitis following Coronary Artery Bypass Graft (CABG) Surgery and Implications for Estimating the Likelihood of Readmission

5.2.1 Introduction

Infections after surgical procedures are an important reason for early readmissions. Herwaldt and colleagues (2006) studied postoperative nosocomial infections associated with general, cardiothoracic, and neurosurgical procedures in a large tertiary care medical center and associated VA hospital. They found that roughly 11% of surgical patients studied acquired at least one nosocomial infection with roughly 8% developing a surgical site infection (SSI). They used on average a 30-day surveillance period post-surgery and detailed clinical data from a clinical trial database to determine the presence of a surgical site infection and found that most SSIs were often diagnosed after discharge. The risk adjusted odds ratio of being readmitted within 30 days of surgery ranged across the three surgical services from 2.15 to 5.62 for patients with a SSI compared with patients with no SSI. A more recent study examined the rate of SSIs for Medicare patients undergoing CABG surgery in 2005 using Medicare claims data and found the rate to range from 7.8% in the best decile of performing hospitals to 24.8% in the worst decile of performing hospitals (Huang *et al*., 2011). However, both of these studies included broad categories of SSIs.

In this study, we are specifically concerned with mediastinitis, a serious infection of the mediastinal space of the chest. Data from the National Nosocomial Infections Surveillance (NNIS) System reports the rate of mediastinitis ranges from 0.1% to 2.3%, depending upon patient risk factors (NNIS, 2004). Swenne *et al*. report that their review of the literature suggests that rate of mediastinitis within 60 days of a CABG ranges from 0.5% to 5% (Swenne et al., 2004). However, co-occurring serious comorbidity also occurs. The rate of concomitant bloodstream infection with mediastinitis is 54%; the rate of multiple organ failure is 12.6%; and mortality ranges from 35% to 40%; (Mekontso Dessap et al, 2010, Kohut et al, 2008).

One area of considerable concern in our readmission analysis is under estimation of the number of surgical site infections (SSI) identified during the acute surgical hospitalization episode. Although we have a high degree of confidence that Medicare claims coded with a SSI are true positive SSIs given the potential negative payment impact, we have less confidence that Medicare claims coded without the SSI HACs are true negative SSIs due to under reporting or delay in clinical presentation until after discharge. The presence of either situation could create an estimation bias in future multivariate modeling of the likelihood of readmission. We believed exploration of the possible degree of this occurrence was warranted and present descriptive analyses of potential degree of post-discharge clinical manifestation of a SSI related to CABG, an important procedure to the Medicare FFS population and a complication that can have significant morbidity effects.

In the sections that follow, we present a mathematical model of readmission estimate bias that occurs when estimating readmissions with identification errors in the dependent variable, a description of our analytic approach and data, findings, and a discussion of implications for future readmission work.

5.2.2 Readmission Estimation Bias

In this section, we develop a mathematical model of readmission estimation bias that occurs when estimating readmissions with identification errors in the dependent variable, a hospital-acquired condition that was not coded and reported. This can occur when clinical manifestation of the HAC occurs after the initial hospital discharge, such as for a SSI, or under-reporting by hospital staff.

We assume that the readmit rate for a HAC infection in hospital h, R_{ih}/A_h, can be decomposed into those readmits that were reported as hospital-acquired during the initial stay, R_{irh}/A_h, and those that went unreported, R_{iuh}/A_h:

(1) $$R_{ih}/A_h = R_{irh}/A_h + R_{iuh}/A_h$$

where A_h = total admissions and R_{ih} = total infection-related readmissions. The usual focus of analysis is on the hospital's reported HAC rate for infections that can be decomposed into the reported rate of all infections incurred during the hospital stay times the rate of all reported (and unreported) HACs in all admissions, i.e.,

(2) $$HAC_{irh} = A_{irh}/A_h = (A_{irh}/A_{ih})*(A_{ih}/A_h).$$

Hospitals can have a higher reported HAC rate if (a) they have more infections in general than average, and/or (b) if they have a higher likelihood of reporting their HACs. A similar unreported HAC rate,

(3) $$HAC_{iuh} = A_{iuh}/A_h = (A_{iuh}/A_{ih})*(A_{ih}/A_h)$$

captures infections that were not reported on the initial admission.

A hospital's infection readmit rate can be written as a weighted sum of its reported and unreported HAC rates:

(4) $$\begin{aligned} R_{ih}/A_h &= (R_{irh}/A_{irh})*(HAC_{irh}) + (R_{iuh}/A_{iuh})*(HAC_{iuh}) \\ &= \delta_i*(HAC_{irh}) + \gamma_i*(HAC_{iuh}) \end{aligned}$$

where $\delta_i = (R_{irh}/A_{irh})$, $\gamma_i = (R_{iuh}/A_{iuh})$, or the readmission rates associated with reported and unreported infections, respectively. Both δ and γ are assumed positive and vary with the type of HAC (e.g., infection, fall) but not hospital. If we insert the two HAC definitions (eq. 2 and 3) into the overall infection readmission equation (4) for hospitals, h and g, we can isolate the factors causing inter-hospital differences in HAC rates:[1]

[1] $(A_{iuh}/A_{ih}) = 1 - (A_{irh}/A_{ih})$.

$$R_{ih}/A_h = (A_{irh}/A_{ih})*(A_{ih}/A_h)*[(\delta-\gamma) + (\gamma/(A_{irh}/A_{ih}))]$$

$$= (HAC_{irh})*[(\delta-\gamma) + (\gamma/(A_{irh}/A_{ih}))] \quad (5)$$

$$R_{ig}/A_g = (A_{irg}/A_{ig})*(A_{ig}/A_g)*[(\delta-\gamma) + (\gamma/(A_{irg}/A_{ig}))]$$

$$= (HAC_{irg})*[(\delta-\gamma) + (\gamma/(A_{irg}/A_{ig}))] \quad (6)$$

Hospital *h* may have a higher infection readmit rate than hospital *g* if its

- reported HAC rate across all admissions is greater: $(HAC_{irh}) > (HAC_{irg})$, or if its
- reported HAC rate of all infections is lower: $(A_{irh}/A_{ih}) < (A_{irg}/A_{ig})$.

Thus, two hospitals may have the same reported HAC rates but different readmit rates per admission leading to little correlation between the presence of a hospital-acquired infection and the likelihood of a readmission. It is also possible that one hospital has a lower reported HAC rate yet has a higher true infection readmit rate. The paradox is explained by the fact that the HAC rate calculated from claims data reflects two factors: the hospital's true, overall, infection rate (once unreported, post-discharge, infections are accounted for) as well as the hospital's rate at which it reports infections. The latter term may be both positive and negative; thus, an ambiguous net effect on the overall infection readmit rate. The reported or coded infection rate can also vary positively or negatively with hospitals' overall infection rate. Thus, it is possible that a hospital has a high reported infection rate of all infections but a low readmission rate, thereby producing a zero correlation of reported HAC rates with readmission rates.

Model Implications. Conceptually, we would expect that the relationship between HAC rates and readmission rates to be positive; a HAC worsens a patient's health and could require multiple hospitalizations to treat. However, the "observed HAC" measure is imperfectly sensitive by failing to capture all true HACs—usually because they are realized only after discharge. As a result, the observed relationship between HAC rates and readmission rates will not match the true relationship.

If the sensitivity is unrelated to the readmission rate and does not vary across providers, then this situation is analogous to the classic errors-in-variables regression problem, and the correlation between observed HAC rates and readmission rates will be lower than the true correlation. This biases the reported HAC coefficient in any readmission model towards zero, producing an under-estimate of the effect of true HACs on readmissions.

However, it is quite likely that the sensitivity of the observed HAC measure does vary systematically across providers (and type of HAC). To see this, consider two hospitals which differ only in their length of stay. One hospital tends to discharge patients as quickly as possible, whereas the second hospital tends to permit patients to stay in the hospital longer. In this hypothetical situation, we assume that the procedure infection rates and other aspects of underlying quality are identical but only the lengths of stay differ. In the early-discharge hospital, the infection may not be identified until after the patient is discharged. The inpatient HAC rate for this hospital will be low, but the readmission rate will be high. In contrast, in the second hospital, since the underlying length of stay is longer, the HAC may be identified and treated in the hospital prior to discharge (even further lengthening that patient's stay length). Assuming the patient is discharged with the HAC fully treated, no readmission would be necessary. Thus, the second hospital's reported inpatient HAC rate will be high, but its readmission rate will be low.

This confounding relationship between observed inpatient HAC rates and readmission rates is due to the fact that hospitals vary on two dimensions. First, hospitals vary in their true HAC rates because of differences in their quality of care. Second, hospitals will vary in their lengths of stay (or any other factor that would impair the sensitivity of the HAC measure). To counteract the confounding length of stay effect, one option must be to extend the time window for measuring (recording) HACs into the post-discharge period. Using readmissions to enhance the measure of true HAC rates can significantly improve the sensitivity of the initial HAC measure and produce a higher, more accurate estimate of the HAC-readmission link. Care must be taken, however, in inferring a HAC when using readmission data. Infections not acquired during the earlier admission will likely be picked up in using readmission data and make the measure somewhat less specific. Readmission data will also be imperfect to the extent that infections and other late-appearing HACs are treated in an ambulatory setting without a subsequent readmission. The modeling suggests taking a careful look at the complex relationship between a very imperfectly measured estimate of hospital-acquired conditions and any subsequent readmission rates. The shorter the window, the greater the likelihood that a HAC had gone unreported during the earlier hospitalization. It also calls for using non-readmission claims to track ambulatory follow-up of HACs (e.g., physician and outpatient department bills).

5.2.3 Background on Clinical Presentation of Mediastinitis Following CABG

Mediastinitis is an infection of the mediastinal structure that occurs in patients who undergo a CABG surgical procedure. Time to onset is generally 5-13 days in early onset cases and up to 30 days in late onset. The majority of CABG procedures are performed by a surgeon accessing the coronary arteries through a midline incision exposing and cutting through the sternum with a vertical saw. After closure of the first surgical procedure, the tissue and bone can become infected and inflamed by bacteria. The bacteria are introduced from a patient's own skin or from the surgical environment through contamination of the wound or surgical site by non-sterile fluids or equipment, through the air, or by shedding from the medical team. Inadequate drainage of the sternum during the surgical procedure is thought to increase the risk for infection. Post-surgical separation of the sternum (sternal dehiscence) can occur and is thought to be an inciting factor to mediastinitis. When the soft tissue or bone becomes infected, tissue necrosis can occur, patients demonstrate symptoms, such as fever and chills, shortness of breath, chest pain or tenderness, and have a general feeling of ill health. If the infection is severe, patients feel confused, have pain in the throat, and become seriously ill and septic within only a few hours. Mortality is high among patients who develop mediastinitis.

5.2.4 Data and Methods

Data. We conducted an analysis of the hospital-acquired condition, mediastinitis, following CABG surgery after discharge to evaluate the potential under-reporting of mediastinitis during the hospital period or clinical presentation of mediastinitis after discharge. We constructed a FY 2009 and FY 2010 episode of care file linking physician and hospital outpatient department

(OPD) claims to MedPAR records for Medicare fee-for-service (FFS) beneficiaries who met the following criteria: (1) residing in the United States, (2) Medicare is primary payer, (3) enrolled in Medicare Parts A & B FFS during the index admission and for the 60 day period post-discharge. In constructing our episode of care file, we started with all MedPAR claims with a procedure code for CABG surgery. We first combined MedPAR records that reflected transfers from one acute care provider to another acute care provider using the admission date from the first MedPAR records and date of discharge from the last MedPAR record. We deleted all MedPAR records for which we could not observe a complete 60-day follow-up period and all MedPAR records for which mediastinitis was present on admission. The balance of MedPAR records (156,684) are considered the index admissions for this analysis to which we linked all physician claims billed during the admission and all physician and hospital outpatient department claims during a 60-day follow-up period.

Roughly 0.2% of index admissions did not have any associated physician claims billed from date of admission through date of discharge, but a larger number of index admissions, 4.6% did not have any associated physician or OPD claims billed during the 60-day post-discharge period. Thus, we have slightly different numbers of claims and cases of hospital-reported mediastinitis using hospital claims only, hospital and physician claims, and hospital and post-discharge claims as we drop from our analyses any hospital records that do not have matching physician or OPD claims. Using the 156,684 index admissions, we identify 72 cases of hospital-reported mediastinitis. Using the 156,309 index admissions with linked physician claims during the admission, we identify 69 cases of hospital-reported mediastinitis. Using the 149,395 index admissions with linked physician or OPD claims for the 60-day post-discharge period, we identify 70 cases of hospital-reported mediastinitis.

Using the MedPAR, physician, and OPD claims, we constructed a number of analytic variables:

- MDDIAGHOSP = 1, if a mediastinitis diagnosis is present on any physician bill in any diagnosis field during the hospital stay using ICD-9 diagnosis code: 519.2

- MDDIAGDATE = the number of days post-surgery that the first physician claim reported a mediastinitis diagnosis

- MDSPEC = carrier line specialty code

- INPCONSULT = 1, if the patient had an inpatient consultation from an infectious disease specialist using HCPCS codes 99251-99255 to identify inpatient consultations and infectious disease specialty code 44

- OPDVISITSURGx = 1, if patient had an ambulatory E&M visit (HCPCS code 99201-99215) with their primary surgeon within 7, 15, 30, and 60 days post-discharge. The primary surgeon was identified using the Claim Operating Physician NPI Number on the hospital bill. This was linked to the Carrier Line Performing NPI Number on the physician bill or Attending NPI or Other Treating Physician on the OPD claim.

- ANYOPDVISITx = 1, if patient had an ambulatory E&M visit (HCPCS code 99201-99215) with any provider within 7, 15, 30, and 60 days post-discharge.

- ANYVISITx = 1, if patient had any E&M visit (HCPCS code 99201-99350) with any provider within 7, 15, 30, and 60 days post-discharge.

- PVISITCDx = Reason for any of the four types of visits using Line Diagnosis Code for all physician line items or the Claim Principal Diagnosis Code or Other Diagnosis Code for all OPD claims.

Methods. We began this evaluation by examining physician billing data during the index admission looking for evidence of an infection or concern about a potential infection, and then evaluated treatment patterns post-discharge through the use of physician and hospital outpatient department billing data. For index admissions with linked physician bills during the hospitalization period, we report the number of discharges with a mediastinitis diagnosis present on any physician bill during the hospitalization and the proximity of the diagnosis to the day of surgery (e.g., prior to surgery, day of surgery, 1, 2, 3…., 60 days after surgery). We stratify by presence of a mediastinitis diagnosis on the hospital bill. We also report the number of discharges with an infection disease specialist consultation and the list the top 10 diagnoses associated with the consultation.

Using physician and hospital outpatient department claims data post-discharge, we report the percentage of beneficiaries who had an ambulatory encounter within 7, 15, and 30 days post-discharge with their primary surgeon. Because Medicare has a 90-day global surgical bundle payment policy whereby the performing surgeon does not typically submit bills to Medicare for additional payment for care related to the surgery, we may not observe in the claims data any post-operative visits to the primary surgeon, even for the treatment of an infection. We will also report the percentage of beneficiaries who had an ambulatory encounter within the above defined windows to any provider. For discharges with an ambulatory encounter post-discharge, we report the following information within a 30-day window, or the most likely period to observe the clinical presentation of mediastinitis, stratified by presence or absence of a hospital-reported case of mediastinitis:

- Percent with a follow-up visit to their primary surgeon

- Percent with a follow-up visit to any provider

- Top 10 reasons for an ambulatory encounter with any provider.

It is important to note that we had proposed a more robust analysis in our previously submitted and accepted Strategy Memo. However, preliminary review of physician billing during and post-discharge for mediastinitis or possibly related clinical conditions was extremely minimal making many of the proposed analyses impractical. We return to this issue in our discussion of the implications of our findings on future readmission analyses.

5.2.5 Findings

The rate of mediastinitis for Medicare beneficiaries undergoing a CABG procedure calculated using FY 2009 and FY 2010 MedPAR claims is low, 0.04 percent of CABG surgical patients had a hospital-reported secondary diagnosis of mediastinitis. The literature suggests the range is from 0.1% to 5%, but the timeframe for diagnosis is generally broader than the acute hospitalization period.

Table 13 displays the number of mediastinitis secondary diagnoses that were reported by acute care hospitals and physicians as having occurred among FFS Medicare beneficiaries undergoing CABG surgery in FY 2009 and 2010. Of the 156,309 CABG discharges with linked physician claims during the hospitalization period, hospitals reported 69 cases of mediastinitis. Of the 156,309 discharges with physician bills, only 126 discharges had a physician diagnosis of mediastinitis during the hospitalization. And, the rate of agreement between hospital and physician coding of mediastinitis is poor. Eighty-two percent of discharges with a physician diagnosis had no accompanying hospital diagnosis and 59% of discharges with a hospital diagnosis had no accompanying physician diagnosis. The very small number of either hospital- or physician-reported cases of mediastinitis makes most proposed analyses and statistical testing impractical. Therefore, we provide a limited number of analyses and no statistical testing.

Table 13
Frequency of hospitals and physicians billing with a mediastinitis diagnosis during a hospitalization for coronary artery bypass graft surgery

Hospital diagnosis of mediastinitis	Physician diagnosis of mediastinitis	Number of discharges
No	No	156,114
No	Yes	126
Yes	No	41
Yes	Yes	28
Total	—	156,309

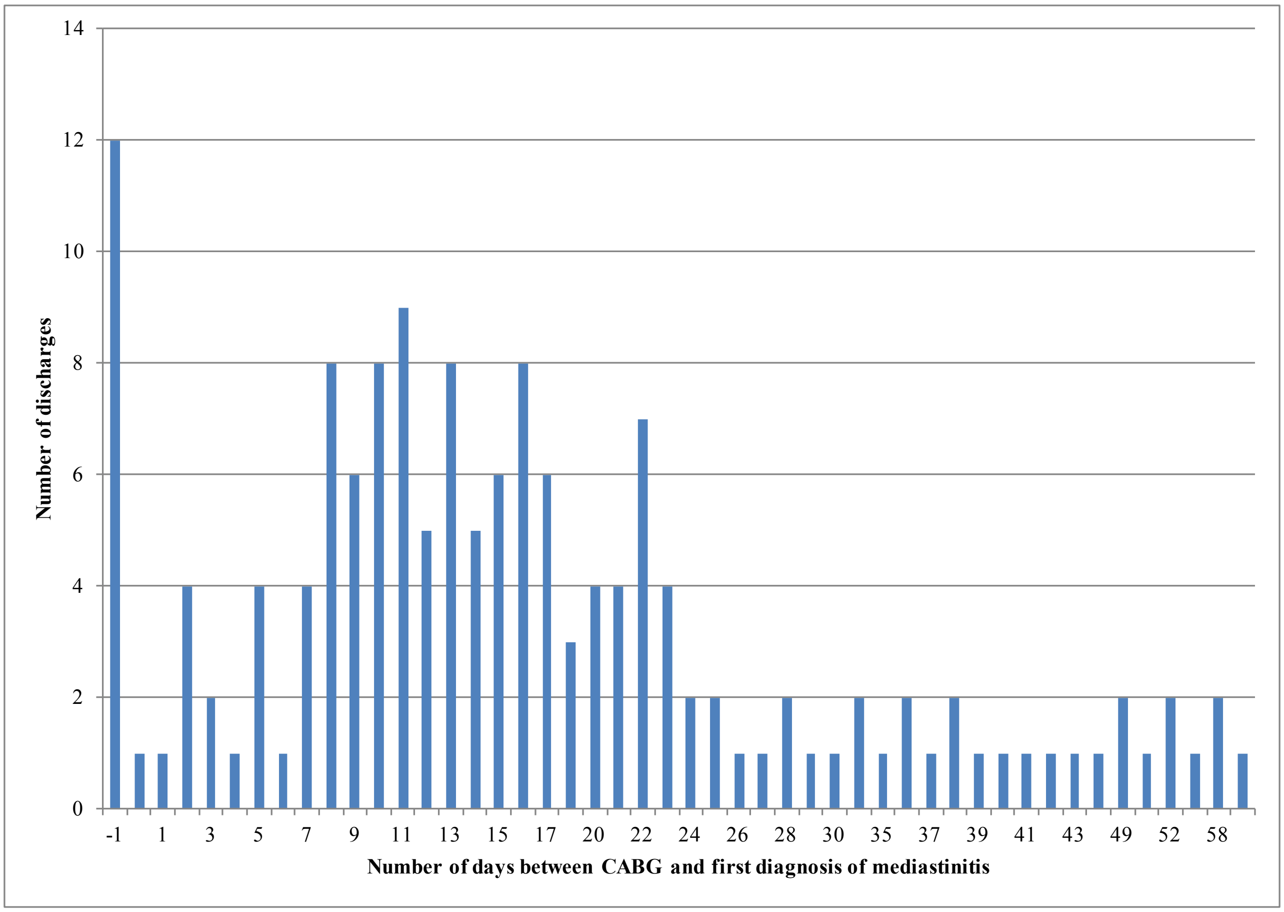
NOTES: 375 MedPAR index admissions did not have any accompanying physician bills during the hospitalization period. The MedPAR records with no accompanying physician claims were excluded from this analysis.

SOURCE: RTI analysis of FY2009 and FY2010 MedPAR and physician claims.

Program: media1_freq_20jan

Figure 4 displays timing to first diagnosis of mediastinitis from date of surgery among the CABG patients with a physician diagnosis of mediastinitis while an inpatient. Interestingly, 12 cases had a mediastinitis diagnosis (but not coded as present on admission) prior to the date of surgery using the "from" date on the physician claim. However, we observe days 9 through 23 post-surgery with the most cases diagnosed. The average length of stay among the studied discharges was 11 days.

Figure 4
Number of days following coronary artery bypass graft surgery to first diagnosis of mediastinitis among 104 medicare beneficiaries with a physician diagnosis of mediastinitis within 60 days of surgery



NOTES: 375 MedPAR index admissions did not have any accompanying physician bills during the hospitalization period. The MedPAR records with no accompanying physician claims were excluded from this analysis.

SOURCE: RTI analysis of FY2009 and FY2010 MedPAR and physician claims.

Program: media1_freq_20jan

Infection disease specialists were most likely to first diagnosis mediastinitis (24%), followed by plastic surgeons (14%), internal medicine specialists (12%), cardiac surgeons (9%), and thoracic surgeons (8%). We examined the top 10 diagnoses (primary or secondary by volume) associated with 11,977 inpatient consultations by infection disease specialists (**Table 14**) stratified by whether or not the hospital reported mediastinitis. Bacteremia (presence of bacteria in the blood) and mediastinitis are among the top 3 diagnoses by the infection disease specialists among patients for whom the hospital reported the presence of mediastinitis. In contrast, less specific infectious diagnoses, fever not otherwise specified (NOS) and leukocytosis NOS, are among the top 3 diagnoses for patients for whom the hospital did not report mediastinitis. Leukocytosis means an elevated white blood cell count and is generally associated with an infection or an inflammatory response. Pneumonia is among the top listed diagnosis for both sets of patients. Bacteremia is the eighth most frequently listed diagnosis among patients without a hospital-reported mediastinitis diagnosis. Mediastinitis is not among the top 10 listed diagnoses among patients without a hospital-reported mediastinitis diagnosis.

We also examined the clinical presentation of mediastinitis post-discharge using a 30-day window as the most clinically relevant period to capture late-stage mediastinitis. Our initial exploration involved an evaluation of the frequency of post-discharge visits to the primary surgeon. Not unexpectedly, we found a very low rate of follow-up evaluation and management (E&M) visits which reflects the bundling of post-surgical visits into the global payment for the CABG procedure. Only 14 out of 149,395 Medicare beneficiaries who had undergone a CABG surgery had a billed E&M visit to their primary surgeon within a 30-day window. Expanding the analysis to a post-discharge ambulatory E&M visit to any provider, we see considerably higher rates of billed E&M visits: 17% of beneficiaries had an ambulatory E&M visit within 7 days; 43% within 15 days; and 71% within 30 days.

Table 15 displays the top 10 reasons for any ambulatory physician visit within 30 days of discharge stratified by whether or not mediastinitis was diagnosed during the hospital period. For discharges that had a mediastinitis diagnosis during the hospital period, there is indication of follow-up treatment for infections, including mediastinitis, among the top 10 diagnoses. In contrast, we see no follow-up treatment for infections among patients who did not have a hospital diagnosis of mediastinitis among the top 10 diagnoses. If we also include post-discharge inpatient and post-acute care E&M visits in our analysis (not displayed), we still do not observe mediastinitis in the top 10 diagnosis list for those beneficiaries without a hospital diagnosis of mediastinitis. Looking across all E&M visits regardless of location and all diagnosis codes on all physician claims, we observe few instances of mediastinitis being listed as a diagnosis within 30 days of discharge, 0.2 percent of cases.

5.2.6 Implications for Future Readmission Analyses

The rate of hospital and physician-reported mediastinitis during hospitalization for CABG surgery is very low with no appreciable reporting of the clinical development of mediastinitis following discharge for up to 30 days. Nor was there much agreement between hospitals and physicians in reporting the presence of mediastinitis.

Table 14
Top 10 reasons for an inpatient consultation among medicare beneficiaries during a hospitalization for coronary artery bypass graft surgery stratified by presence or absence of hospital-reported mediastinitis

Hospital-Reported Mediastinitis

Number of Discharges = 69
Number of Inpatient Consultations = 28

Diagnosis	Frequency
Bacteremia	16
Bacterial pneumonia	12
Mediastinitis	11
Pneumonia- gram negative bacteria	9
Fever NOS	8
Other postoperative infection	8
Open wound chest-complication	7
Coronary Athrosclerotic Native Vessel	6
Post-trauma wound infection	6
Leukocytosis NOS	5

Hospital-Reported No Mediastinitis

Number of Discharges = 156,240
Number of Inpatient Consultations = 8,246

Diagnosis	Frequency
Coronary Athrosclerotic Native Vessel	2,640
Fever NOS	2,440
Leukocytosis NOS	2,334
Pneumonia, organism NOS	1,732
Urinary tract infection	1,132
Coronary Athrosclerotic Unspecified Native Vessel Graft	1,128
White Blood Cell Disease	906
Bacteremia	891
Septicemia NOS	873
Diabetes Mellitus without complication	854

NOTES: 375 MedPAR index admissions did not have any accompanying physician bills during the hospitalization period. The MedPAR records with no accompanying physician claims were excluded from this analysis.

SOURCE: RTI analysis of FY2009 and FY2010 MedPAR and physician and hospital OPD claims.

Program: media1_freq_20jan

Table 15
Top 10 reasons for an ambulatory evaluation and management visit among medicare beneficiaries within 30 days of discharge from a hospitalization for coronary artery bypass graft surgery stratified by presence or absence of hospital-reported mediastinitis

Hospital-Reported Mediastinitis

Number of Discharges = 69
Number of Outpatient E&M Visits = 29

Diagnosis	Frequency
Coronary Athrosclerotic Native Vessel	32
Open wound chest-complication	14
Aortocoronary bypass	14
Other postoperative infection	12
Mediastinitis	11
Reaction - cardiac device/graft	9
Vaccine for influenza	8
Coronary Athrosclerotic Unspecified Native Vessel Graft	3
Acute respiratory failure	6
Long-term use antibiotic	6

Hospital-Reported No Mediastinitis

Number of Discharges = 149,367
Number of Outpatient E&M Visits = 110,930

Diagnosis	Frequency
Coronary Athrosclerotic Native Vessel	132,960
Coronary Athrosclerotic Unspecified Native Vessel Graft	69,687
Diabetes Mellitus	37,939
Atrial fibrillation	32,411
Aortocoronary bypass	19,781
Benign hypertension	19,246
Hypertension NOS	17,809
CHF NOS	15,793
Aortic Valve Disorder	15,280
Hyperlipidemia NEC/NOS	14,188

NOTES: 7,289 MedPAR index admissions did not have any accompanying physician or hospital OPD bills during the follow-up period. The MedPAR records with no accompanying physician or OPD claims were excluded from this analysis.

SOURCE: RTI analysis of FY2009 and FY2010 MedPAR and physician and hospital OPD claims.

Program: media1_freq_20jan

This analysis was conducted to better understand the degree to which readmission estimation bias is of concern due to clinical presentation of mediastinitis after discharge. On the surface, the low rate of occurrence after discharge would suggest that readmission estimation bias is of little concern. Analysis of reasons for visits to all providers showed a rate of mediastinitis at the low end of the range reported in the literature, 0.2 percent of cases. Given comorbidity characteristics of Medicare beneficiaries relative to the under-65 population receiving a CABG procedure, we would expect to see a higher rate of mediastinitis being reported. However, the rate of observed interactions between the patient and their primary surgeon was extremely low; only 14 out of 149,395 Medicare beneficiaries had a follow-up appointment within 30 days. This low number is likely a reflection of the global billing payment policy. Thus, it would appear that the use of Medicare claims with the global billing convention may not be an adequate source of information to conduct this analysis.

SECTION 6
SUMMARY AND CONCLUSIONS

We examined the rates and reasons for all-cause readmissions among all discharges in FY 2009 and the first 10 months of FY 2010 in which a HAC was coded by the hospital and the patient was discharged alive. The rates of readmission varied considerably across the different HACs, with the lowest readmission rate for DVT/PE following certain orthopedic procedures and the highest readmission rate for blood incompatibility and the SSI of mediastinitis following CABG. Readmission rates increase as the readmission window expands from 7 days to 60 days.

Between FY 2009 and FY 2010, we did not discover any large changes in the readmission rates for any of the HACs, except for among the low-volume surgical site infections, where fluctuations in the readmission rate from year to year likely has more to do with small sample sizes than with actual changes in readmissions for this patient population. Septicemia and pneumonia were among the most common primary diagnoses for readmission across many of the HACs, and for the surgical site infections, post-operative infections were a common reason for readmission. Comparing FY 2009 and FY 2010 data, we did not detect any substantive changes in the reasons for readmission following the HACs.

To address the *incremental* effect of a HAC on readmissions for falls and trauma, vascular catheter associated infections, and DVT/PE following certain orthopedic procedures, we developed comparison groups for each of the three HACs using a random sample of discharges matched to the HAC cases by key clinical and demographic characteristics. For all three HACs, we find large and statistically significant differences in the readmission rates between the HAC cases and the matched comparison groups. FY 2009 and FY 2010 readmission rates were 3 to 6 percentage points higher for discharges with the falls and trauma HAC, 6 to 7 percentage points higher for discharges with the vascular catheter-associated infection HAC, and 2 to 3 percentage points higher for discharges with the DVT/PE following certain orthopedic procedures HAC, respectively.

Although we find that readmission rates vary by key patient criteria, such as age, Medicaid status, disability status, and HCC scores, differences in readmission rates between discharges with the HAC and its respective comparison group persist across most of these stratifications. The same is true when we stratify by important hospital characteristics such as geographic region, urban location, and size.

While the rates of readmission for the beneficiaries who acquired one of the three conditions during their hospitalization are much higher than for comparison beneficiaries, we find many of the same reasons for readmission for these two groups across our two years of data. The primary exception is the “infection of a central venous catheter” is one of the top five reasons for readmission among those with a hospital-acquired vascular catheter associated infection, while this is not among the top reasons for readmission among the comparison group beneficiaries.

In a separate analysis examining the claims coded as POA (POA indicator equal to “Y” or “W”), we found virtually no cases where the index POA hospital claim could be matched to a previous hospital claim where the same condition was coded as hospital-acquired within the 60-

day look-back window. This is likely due to the fact that many of the HAC-associated diagnoses considered can occur in medical settings other than a hospital, and also in the home/community (for HAC-associated diagnoses such as falls and trauma and poor glycemic control).

Comparing rates of readmission using an all-cause definition versus a definition of "unplanned" as developed by a team of researchers at Yale for CMS, we observe two findings. First, the number of discharges at risk for readmission decline most notably for cases involving the vascular catheter-associated infection. This likely reflects the exclusion of discharges related to medical treatment for cancer, in which many patients receiving ongoing chemotherapy have central lines placed. Second, the rates of readmission using the unplanned definition of readmission are lower than all-cause but not more than 3 percentage points and the observed differences in readmission rates between beneficiaries with and without the three studied HACs are quite stable. Thus, our finding of differential rates of readmission amongst beneficiaries with one of the three HACs is quite insensitive to the cause of readmission definition used.

And lastly, we examined the degree to which readmission estimation bias may be present in the Medicare claims data due to under-reporting of mediastinitis by hospitals or a delay in clinical presentation until after discharge. We found low rates of reporting of mediastinitis by physicians during and after discharge from the hospital. More importantly, the rate of observed interactions between the patient and their primary surgeon post-discharge was extremely low; only 14 out of 149,395 Medicare beneficiaries had a follow-up appointment within 30 days. This low number is likely a reflection of the global billing payment policy. Thus, it would appear that the use of Medicare claims with the global billing convention may not be an adequate source of information to conduct this analysis.

This low number is likely a reflection of the global billing payment policy. Thus, it would appear that the use of Medicare claims with the global billing convention may not be an adequate source of information to conduct post-discharge analyses for beneficiaries having major surgical procedures subject to the global surgical payment policy. Medicare claims for beneficiaries hospitalized for medical reasons or minor surgical procedures may be more useful in identifying clinical presentation of HAC-associated diagnoses post-discharge as there are no billing restrictions. We plan on evaluating the rate of clinical presentation of the HAC-associated diagnoses post-discharge more broadly in Phase III. We will also explore in Phase III the availability of Part D claims data to identify prescribed antibiotics appropriate for treatment of mediastinitis for patients who received a CABG and did not have a diagnosis of mediastinitis during the hospitalization. We will also examine the prevalence of mediastinitis if one uses procedures that are common for treatment of the condition, e.g., surgical debridement of tissue or bone, rather than relying upon strictly upon the diagnosis of mediastinitis.

REFERENCES

Ashton, C.M., DelJunco, D.J., Souchek, J., et al.: The association between the quality of inpatient care and early readmission: a meta-analysis of the evidence. Med. Care 35(10):1044-1059, October 1997.

Averill, R.F., McCullough, E.C., Hughes, J.S., et al.: Redesigning the Medicare Inpatient PPS to Reduce Payments to Hospitals with High Readmission Rates. Health Care Financ. Rev. 30(4):1-15, Summer 2009.

Encinosa, W.E., and Hellinger, F.J.: The impact of medical errors on ninety-day costs and outcomes: an examination of surgical patients. HSR: Health Serv. Res. 43(6):2067-2085, December 2008.

Friedman, B., and Basu, J.: The rate and cost of hospital readmissions for preventable conditions. Med. Care Res. Rev. 61(2):225-240, June 2004.

Friedman, B., Encinosa, W., Jiang, J.H., et al.: Do patient safety events increase readmissions? Med. Care 47(5):583-590, May 2009.

Goldfield, N.I., McCullough, E.C., Hughes, J.S., et al.: Identifying potentially preventable readmissions. Health Care Financ. Rev. 30(1):75-91, Fall 2008.

Herwaldt, L.A., Cullen, J.J., Scholz, D., et al.: A prospective study of outcomes, healthcare resource utilization, and costs associated with postoperative nosocomial infections. Infect. Control Hosp. Epidemiol. 27(12):1291-1298, December 2006.

Huang S.S., Placzek H., Livingston J., et al. Use of Medicare claims to rank hospitals by surgical site infection risk following coronary artery bypass graft surgery. Infect. Control Hosp. Epidemiol. 2011 Aug;32(8):775-83.

Jencks, S.F., Williams, M.V., and Coleman, E.A.: Rehospitalizations among patients in the Medicare fee-for-service program. N. Engl. J. Med. 360(14):1418-1428, April 2009.

Kohut, K. Guide for the Prevention of Mediastinitis Surgical Site Infections Following Cardiac Surgery. Association for Professionals in Infection Control and Epidemiology. 2008.

Morris, D.S., Rohrbach, J., Rogers, M., Sundaram, L.M.T., Sonnad, S., Pascual, J., Sarani, B., Reilly, P., and Sims, C.: The Surgical Revolving Door: Risk Factors for Hospital Readmission. Journal of Surgical Research, January 2011.

National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004. Am. J. Infect. Control 2004; 32:470-85.

Rosenbaum, P.R., and Rubin, D.B.: The central role of the propensity score in observational studies for causal effects. Biometrika 70:41-55, 1983.

Swenne, CL, Linholm, C. Borowiec, J. Carlsson, M.: Surgical-site infections within 60 days of CABG, J. Hosp. Infect. (2004); 57(1):14-24 - Reported .5 - 5% within 60 days post discharge.

APPENDIX A

Appendix Table A-1
List of potentially planned procedures used to create the Yale "Unplanned" Readmissions Measure

Procedure CCS	Description
1	Incision and excision of CNS
3	Laminectomy; excision intervertebral disc
10	Thyroidectomy; partial or complete
36	Lobectomy or pneumonectomy
43	Heart valve procedures
44	Coronary artery bypass graft (CABG)
45	Percutaneous transluminal coronary angioplasty (PTCA)
48	Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/ defibrillator
51	Endarterectomy; vessel of head and neck
52	Aortic resection; replacement or anastomosis
55	Peripheral vascular bypass
60	Embolectomy and endarterectomy of lower limbs
64	Bone marrow transplant
74	Gastrectomy; partial and total
78	Colorectal resection
84	Cholecystectomy and common duct exploration
85	Inguinal and femoral hernia repair
99	Other OR gastrointestinal therapeutic procedures
104	Nephrectomy; partial or complete
105	Kidney transplant
113	Transurethral resection of prostate (TURP)
114	Open prostatectomy
119	Oophorectomy; unilateral and bilateral
124	Hysterectomy; abdominal and vaginal
152	Arthroplasty knee
153	Hip replacement; total and partial
154	Arthroplasty other than hip or knee
157	Amputation of lower extremity
158	Spinal fusion
166	Lumpectomy; quadrantectomy of breast
167	Mastectomy
176	Other organ transplantation
211	Therapeutic radiology for cancer treatment
	Radical laryngectomy, revision of tracheostomy, scarification of pleura (ICD-9 Codes 30.4, 31.74, 34.6)
	Electroshock therapy (ICD-9 Codes 94.26, 94.27)

Appendix Table A-2
List of acute conditions and complications of care used to create the Yale "Unplanned" Readmissions Measure

Condition CCS	Definition
2	Septicemia (except in labor)
55	Fluid and electrolyte disorders
97	Peri-; endo-; and myocarditis; cardiomyopathy (except that caused by tuberculosis or sexually transmitted disease)
100	Acute myocardial infarction
105	Conduction disorders
106	Cardiac dysrhythmias
108	Congestive heart failure; nonhypertensive
109	Acute cerebrovascular disease
112	Transient cerebral ischemia
116	Aortic and peripheral arterial embolism or thrombosis
122	Pneumonia (except that caused by tuberculosis or sexually transmitted disease)
127	Chronic obstructive pulmonary disease and bronchiectasis
130	Pleurisy; pneumothorax; pulmonary collapse
131	Respiratory failure; insufficiency; arrest (adult)
139	Gastroduodenal ulcer (except hemorrhage)
145	Intestinal obstruction without hernia
146	Diverticulosis and diverticulitis
153	Gastrointestinal hemorrhage
157	Acute and unspecified renal failure
159	Urinary tract infections
160	Calculus of urinary tract
201	Infective arthritis and osteomyelitis (except that caused by tuberculosis or sexually transmitted disease)
207	Pathological fracture
225	Joint disorders and dislocations; trauma-related
226	Fracture of neck of femur (hip)
227	Spinal cord injury
229	Fracture of upper limb
230	Fracture of lower limb
231	Other fractures
232	Sprains and strains
233	Intracranial injury
237	Complication of device; implant or graft
238	Complications of surgical procedures or medical care
245	Syncope

Appendix Table A-3
List of conditions used to identify cancer admissions

Condition CCS	Definition
11	Cancer of head and neck
12	Cancer of esophagus
13	Cancer of stomach
14	Cancer of colon
15	Cancer of rectum and anus
16	Cancer of liver and intrahepatic bile duct
17	Cancer of pancreas
18	Cancer of other GI organs; peritoneum
19	Cancer of bronchus; lung
20	Cancer; other respiratory and intrathoracic
21	Cancer of bone and connective tissue
22	Melanomas of skin
23	Other non-epithelial cancer of skin
24	Cancer of breast
25	Cancer of uterus
26	Cancer of cervix
27	Cancer of ovary
28	Cancer of other female genital organs
29	Cancer of prostate
30	Cancer of testis
31	Cancer of other male genital organs
32	Cancer of bladder
33	Cancer of kidney and renal pelvis
34	Cancer of other urinary organs
35	Cancer of brain and nervous system
36	Cancer of thyroid
37	Hodgkin`s disease
38	Non-Hodgkin`s lymphoma
39	Leukemias
40	Multiple myeloma
41	Cancer; other and unspecified primary
42	Secondary malignancies
43	Malignant neoplasm without specification of site
44	Neoplasms of unspecified nature or uncertain behavior
45	Maintenance chemotherapy; radiotherapy

Appendix Table A-4
List of conditions used to identify psychiatric admissions

Condition CCS	Definition
650	Adjustment disorders
651	Anxiety disorders
652	Attention-deficit, conduct, and disruptive behavior disorders
654	Developmental disorders
655	Disorders usually diagnosed in infancy, childhood, or adolescence
656	Impulse control disorders, NEC
657	Mood disorders
658	Personality disorders
659	Schizophrenia and other psychotic disorders
662	Suicide and intentional self-inflicted injury
670	Miscellaneous disorders